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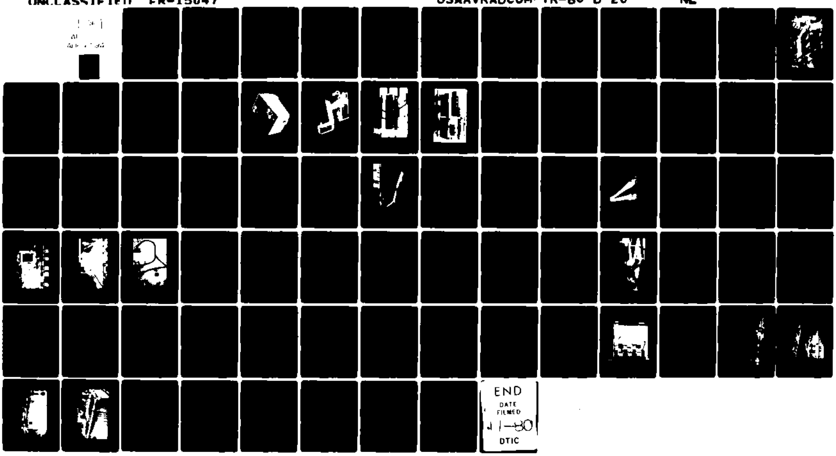

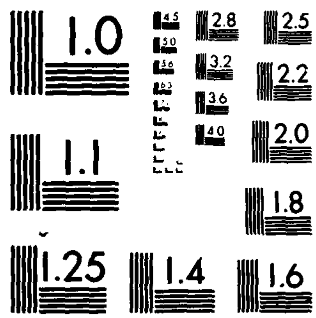

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CONTAINER LIFT ADAPTER—HELICOPTER (CLAH) OPERATIONAL PROTOTYPE (PREPRODUCTION) MILITARIZED UNITS FOR FLIGHT EVALUATION AND OPERATIONAL TESTING

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August 1980

Final Report for Period September 1978 - April 1980

Approved for public release;
distribution unlimited.

Prepared for

APPLIED TECHNOLOGY LABORATORY
U. S. ARMY RESEARCH AND TECHNOLOGY LABORATORIES (AVRADCOM)
Fort Eustis, Va. 23604

APPLIED TECHNOLOGY LABORATORY POSITION STATEMENT

This report represents the advanced development effort to fabricate and test the militarized Container Lift Adapter - Helicopter (CLAH). The conclusions and recommendations contained in this report are generally concurred in by this Laboratory.

The hardware and software delivered under this contract will be used in development and operational testing, the next step in the validation phase of the system acquisition/development cycle.

Mr. J. F. Tansey, Aeronautical Systems Division, served as Project Engineer for this effort.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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HELICOPTERS
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EXTERNAL CARGO
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FUNCTIONAL TEST
STRUCTURE PROOF TEST
RELIABILITY ANALYSIS
MAINTAINABILITY ANALYSIS
LOGISTIC ANALYSIS
INSTRUCTION MANUAL
GENERAL MAINTENANCE/TRAINING MATERIAL

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report covers the efforts required to manufacture and test two operational preproduction militarized CLAHs for Army flight evaluation and operational suitability. The CLAH is an external load-carrying device that is suspended under a cargo helicopter and enables the helicopter flight crew to automatically align with, engage, lock on, pick up, transport, and deposit an 8- x 8- x 20-foot MILVAN or commercial container without assistance of ground crew. This production prototype CLAH design has evolved from a series of contracts involving research, study, development, and testing of experimental container lifting devices. The design change per this contract included eliminating the retractable guide system and the pyrotechnic emergency jettison system.

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Reliability, maintainability, logistic and cost analyses were conducted, and orientation/training sessions were provided to enable Government personnel to operate, maintain, repair, and provide logistic support for the CLAH field test program.

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INTRODUCTION

HISTORY

Container military cargo is recognized as a fundamental element in the U.S. Army's Logistics Support System, and increased emphasis is being directed toward developing more efficient means of utilizing this mode of cargo containment. Currently, the major limiting factors in the effective utilization of helicopters for the movement of containerized cargo are the time and manpower requirements for acquiring and releasing the load. Previous research and development resulted in the conception of an experimental container handling device for transporting standard 8- x 8- x 20-foot U.S. Army MILVAN and commercial ANSI/IS containers by CH-47 and CH-54 helicopters without the aid of ground handling personnel. Two experimental CLAHS were fabricated and limited testing was performed which demonstrated the technical feasibility of the concept and identified configuration and component improvements essential for operating suitability. As a result of the success of this program, a lightweight, flightworthy CLAH was designed for limited production and flight evaluation. This design is actually a "production design" with the exception that machined hog-out parts are utilized in lieu of castings or forgings to facilitate the fabrication of a small quantity of units.

STATUS

The design, development and laboratory testing establishing the conceptual Helicopter-Transported Container Handling Device was completed by Boeing Vertol under Contract DAAJ02-72-C-0083.

The lightweight, flightworthy CLAH design for limited production was accomplished by Boeing Vertol under Contract DAAJ02-76-C-0005 for the structure/mechanical and Contract DAAJ03-77-C-0001 for the electrical.

OBJECTIVE

The objective of the effort described herin was to manufacture and test two operational preproduction militarized CLAHS for Army flight evaluation and operational suitability. Software analysis, reports, and orientation/training sessions were called for to enable Government personnel to operate, maintain, repair, and support the CLAH field test program.

CLAH DESCRIPTION

GENERAL INTRODUCTION

The Container Lift Adapter-Helicopter (CLAH) is an external, load-carrying device that is suspended under a cargo helicopter and enables the helicoper flight crew to automatically pick up, transport and deposit an 8- x 8- x 20-foot MILVAN or commercial container without the assistance of a ground crew. The first production prototype CLAH is shown in Figure 1. An isometric view depicting overall CLAH dimensions is presented in Figure 2.

Power to lock and unlock the twistlocks is supplied from the helicopter by an umbilical cord. Once the twistlocks engage and the MILVAN/container corner fittings, they are rotated 90° to lock in place and enable transporting the container.

Power and control for the electrical system are supplied through the umbilical cord and a portable hand-operated control box that is carried in the helicopter.

Two microswitch sensing systems are built into the corner twistlocks. One system establishes that the CLAH is correctly positioned with all four corners down flush with the container. The second system indicates that the twistlocks are either all in the locked position or in the unlocked position.

The six self-alignment guides (one on each end, two on each side) normally extend downward and outward. They serve to funnel the twistlocks into engagement of free-standing MILVANS. The guides may be manually rotated 162° into their upward position to facilitate parking for maintenance access and transportability.

Hinged fittings are provided on top of the CLAH frame at each of the four corners. These fittings are designed to accept a pair of inverted "V" suspension slings that are compatible with the tandem dual-hook system.

The CLAH consists of three major subsystems: The ELECTRICAL SYSTEM, the STRUCTURAL SYSTEM and the MECHANICAL SYSTEM.

ELECTRICAL SYSTEM

The electrical system supplies power to the electric actuator linked to the twistlocks. The electrical system also carries the command signals and indicates the system status through indicator lights. The major subsystems for the electrical system are the portable control box, the junction box, the stowage box, the umbilical cord, the interconnecting wiring, the electrical actuator and the microswitch assemblies. The relationship of the major electric elements and the interconnecting cabling is illustrated in Figures 3 and 4.

Figure 1. Container Lift Adapter-Helicopter (Final Assembly)

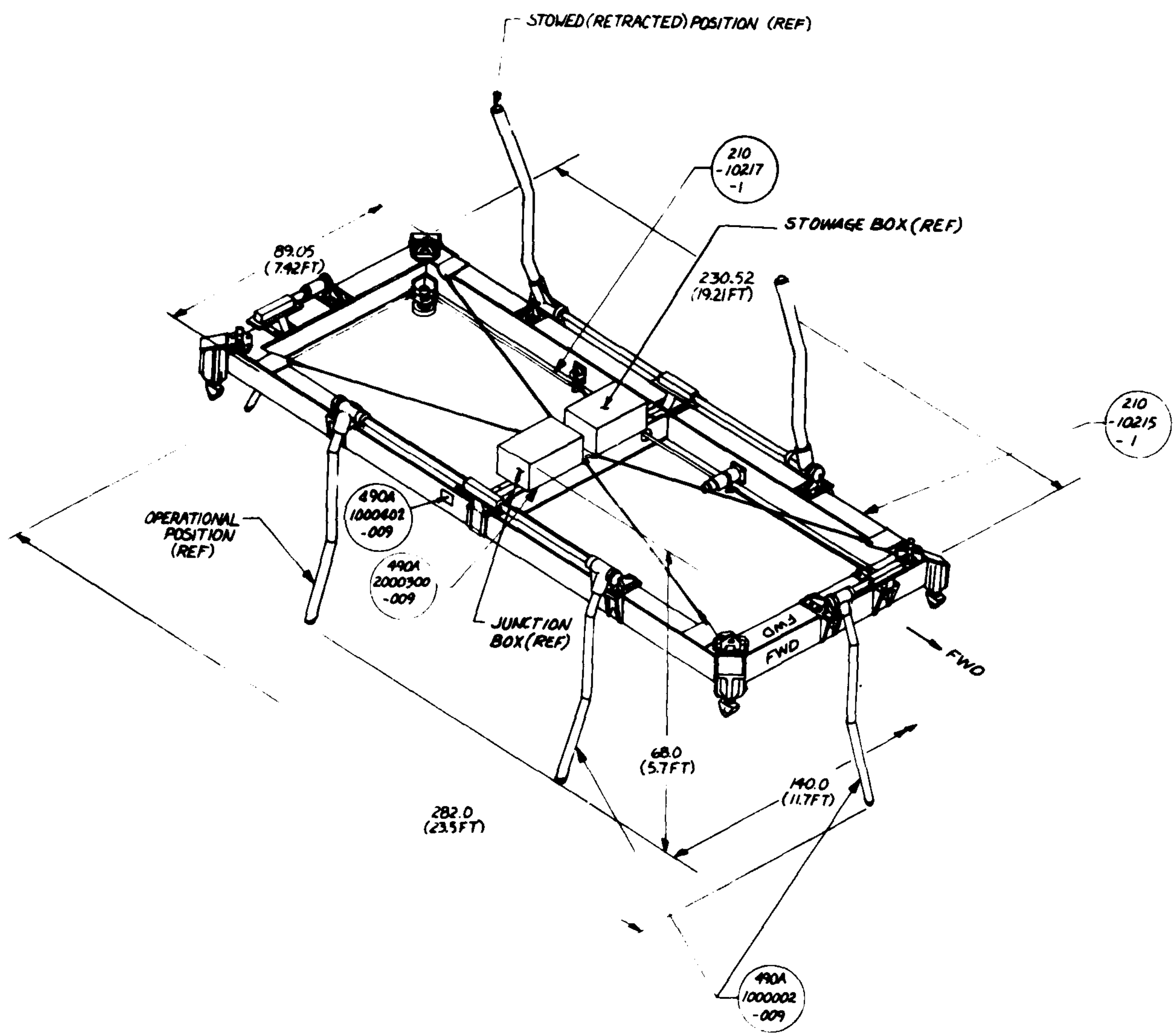


Figure 2. Container Lift Adapter (CLAH)

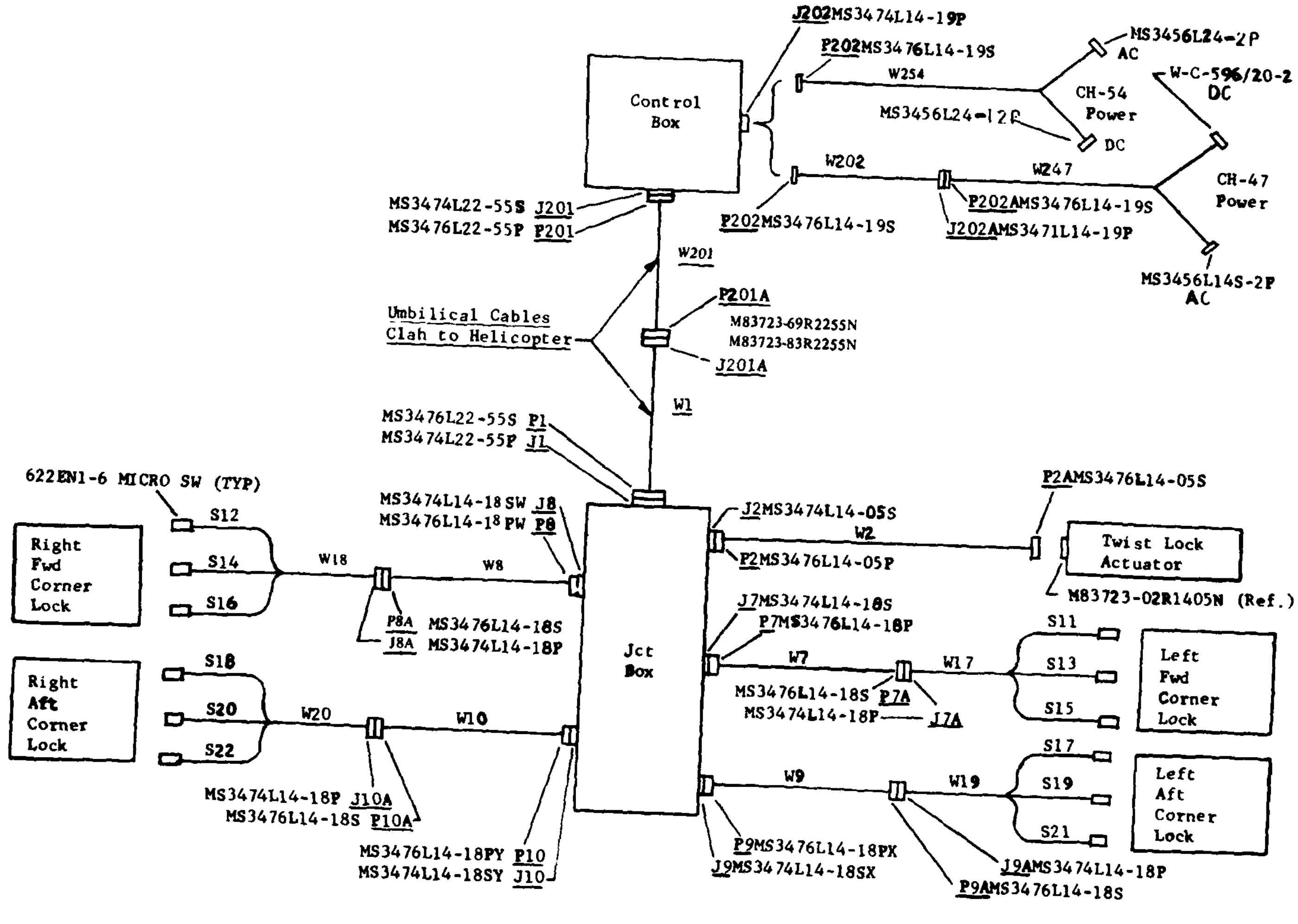


Figure 3. CLAH Systems Diagram

CLAH Drawing Reference-Electrical System

Cable/Part No. Cross Reference

Cable No.	Part No.		Usage Location
W1	490A2000302-039	(55)	Umbilical Cable-CLAH to A/C
W2	-029	(5)	Electrical System-installed in CLAH
W7	-049	(19)	
W8	-059		
W9	-069		
W10	-079	(19)	
W17	-109	(18)	
W18	-109		
W19	-109		
W20	-109	(18)	Electrical system-installed in CLAH
W201	-009	(55)	Umbilical cable-CLAH to A/C
W202	-019	(19)	Power supply hook-up- Routed within CH47 A/C
W247	-089	(19)	
W254	490A2000302-099	(19)	Power supply hook-up - Routed within CH54 A/C

No of conductors:
- (19) = 19 conductor cable assy 490A2000702
- (55) = 55 conductor cable assy 490A2000701
- (5) = 5 individual conductors in vinyl shrink tubing
- (18) = 18 individual pigtails (supplied with micro switches) in vinyl shrink tubing.

Adjustment/Checkout/Control Boxes

Control Box	490A2000100
Junction Box	490A2000200

Installations

Electrical System	490A2000300

Assemblies

Cable Assy	490A2000302
Control Box and Cables Wiring Diagram	490A2000103
Junction Box and Cables Wiring Diagram	490A2000203
Wiring Instructions	490A2000303

Figure 4. CLAH Systems Drawing Reference

Control Box

The control Box (Figures 5 and 6) provides the helicopter crewman with control functions and status indications for operating the CLAH twistlocks.

The control box panel contains the following:

- Power on-off switch
- AC power-on indicator
- DC power-on indicator
- Corner interlock "down" indicator
- Corner interlock "not down" indicator
- Twistlocks "lock/unlock" switch
- Twist interlock "locked" indicator
- Twist interlock "unlocked" indicator

The panel forms the cover of 10 in. x 6½ in. x 4 in. aluminum box. A pivoted aluminum handle is provided for carrying the box and may be used to position the box at an inclined angle when in use. The bottom end of the box mounts two connectors: one outlet to connect with junction box on the CLAH proper by means of the umbilical cord; the other outlet to the AC and DC power sockets in the helicopter. Within the box are contained the wiring, diodes, and relays necessary to its function.

Junction Box

The aluminum 24½ in. x 10-3/16 in. x 8 in. junction box is mounted on the center beam of the CLAH frame (see Figure 7). Six connector receptacles are mounted along one side: one connection for the umbilical cord leading from the control box, one leading from the junction box to the electrical actuator, and four leading to the four twistlocks. A hinged, sealed cover provides access to the interior of the box. With the cover open, a shelf mounting two (MS27400) relays, twelve indicator lights and a (MS27786) test/setup/off switch is accessible. Below this shelf is a second shelf mounting eight terminal blocks. Both shelves are assembled to a support structure attached to the box by the six connector receptacles retaining nuts. All wiring is completed on the support structure and shelves while outside the box and the wired assembly is installed inside the box and retained by the electrical connector nuts and two bolts. The twelve indicators are arranged in four triplets: one triplet for each corner twistlock labeled A, B, C, and D corresponding to markings on the corners of the CLAH frame. The three lights in each triplet indicate "down," twistlock "locked," and twistlock "unlocked." They are designed as built-in test equipment for troubleshooting a malfunction to a particular twistlock location and function.

Stowage Box

The 20-15/16 in. x 10-11/16 in. x 8 in. stowage box is mounted on the center beam of the CLAH, adjacent to the junction box (see Figure 8). It serves to stow the control box, the umbilical cord cables, and the power supply cables for the CH-47 and CH-54 helicopters.

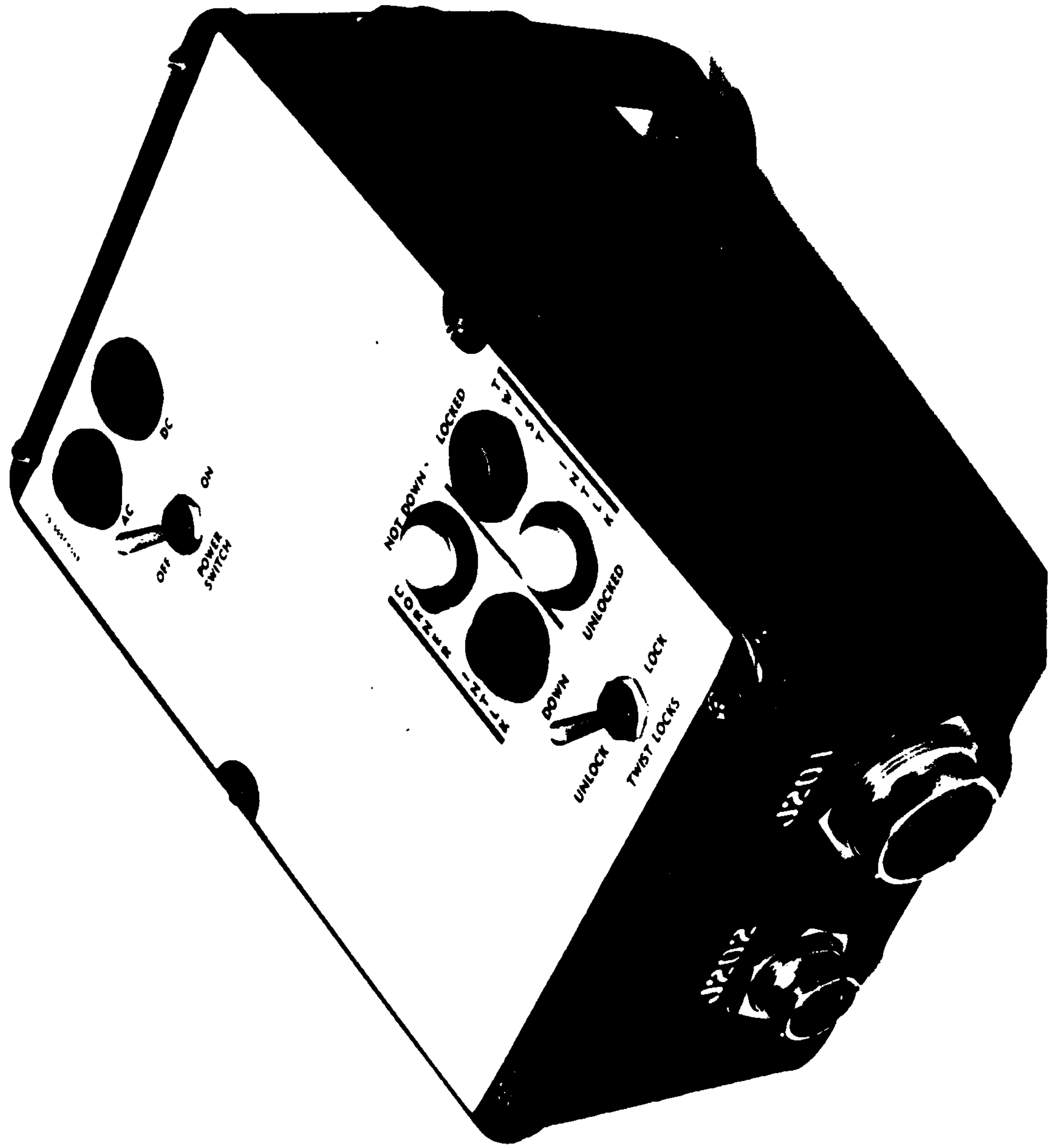


Figure 5. Portable Control Box

Figure 6. Control Box Interior Arrangement

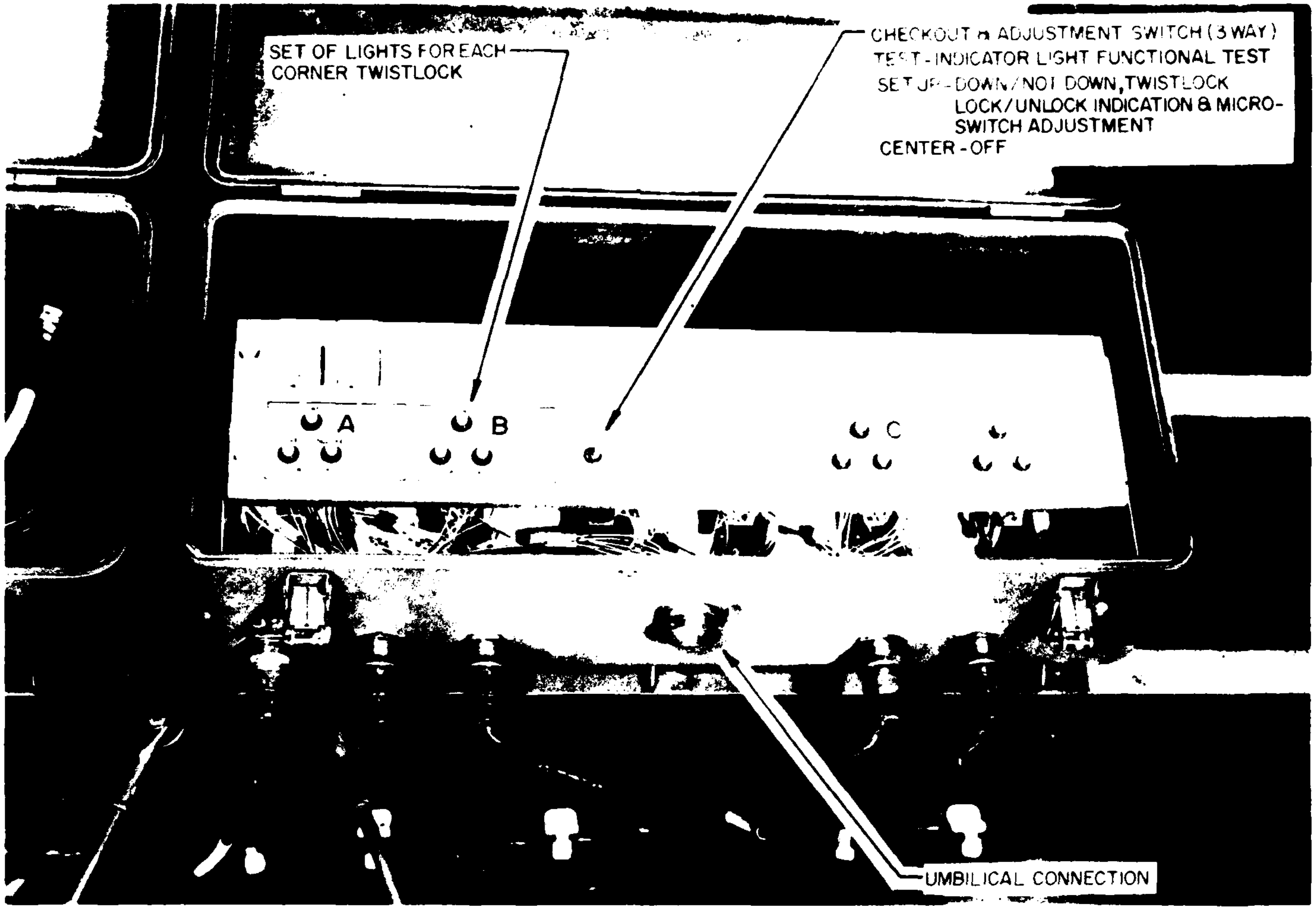


Figure 7. Junction Box

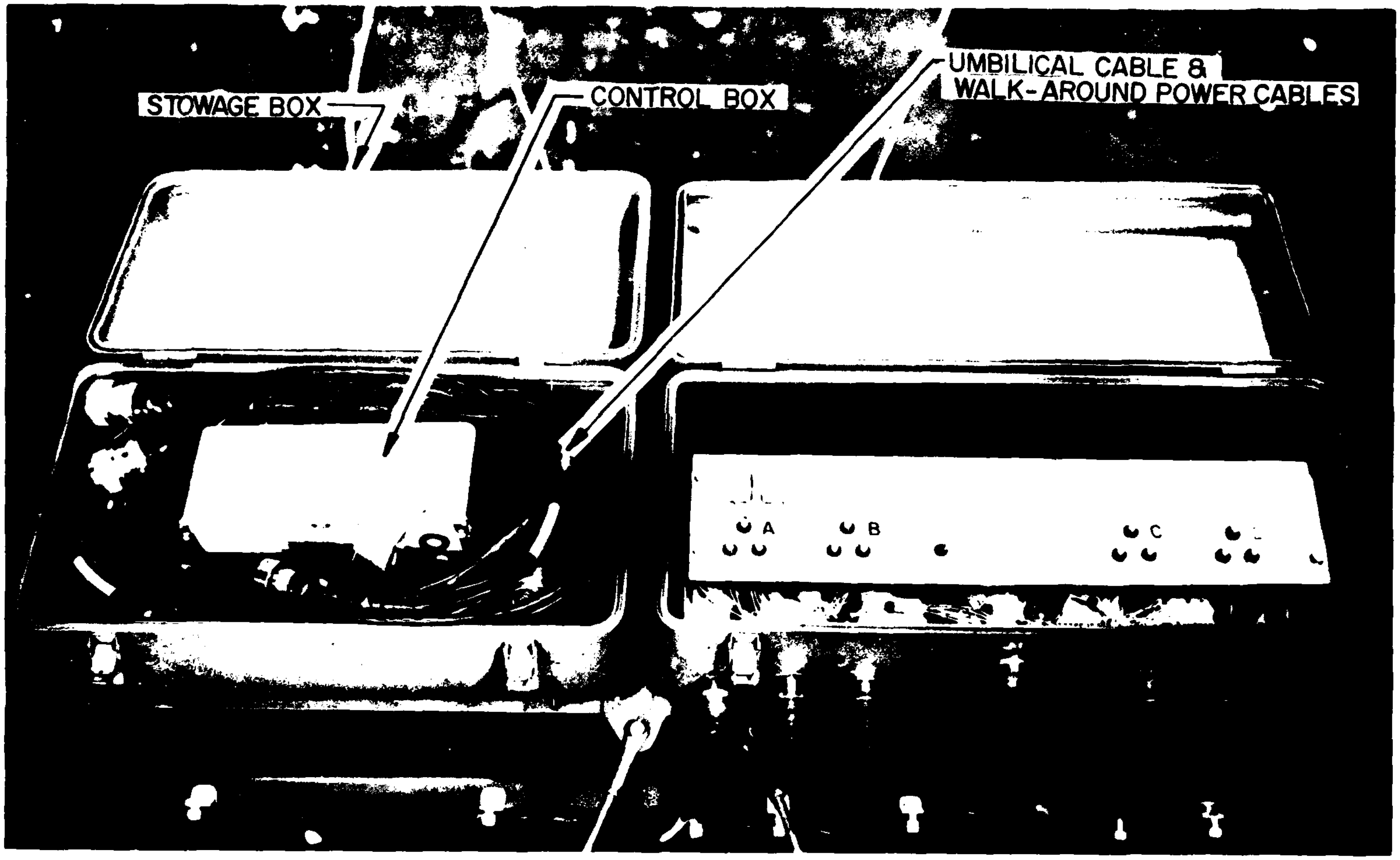


Figure 8. Stowage Box

The Umbilical Cord

The umbilical cord, in two sections connected by a breakaway fitting, interconnects the portable control box in the helicopter with the CLAH junction box and contains both power and signal transmitting wires (Figure 3). The multiple wires in the cord are shielded and jacketed. The lower end has a connector to mate with the junction box. The upper end has the lower half of a breakaway connector assembly. The breakaway assembly allows the umbilical to separate from the helicopter in the event the CLAH is released by opening the hooks in flight. The upper section of the breakaway fitting is assembled to the cable that terminates in the control box. A steel wire lanyard is attached to the upper end of the breakaway fitting, which in turn is clipped to a floor tie-down ring in the CH-47 (Figure 9) or a lashing ring on the CH-54 (Figure 10). The breakaway fitting operates such that when the tension on the umbilical exceeds the design breakaway values, the lanyard restraint causes the connector locking ring to be withdrawn relative to the connector attachment latches, permitting the latches to open and the two connector halves to separate.

Interconnecting Wiring

The CLAH interconnecting wiring consists of cable assemblies routed from the junction box to the four twistlock locations and to the actuator (Figure 3).

Four cables, one for each twistlock, are routed from the junction box to the four corners. Each cable terminates with a quick-disconnect connector near the twistlock fitting. A short cable is routed from this connector to the microswitches. The connectors at the junction box are keyed to ensure that the correct cable is connected to the respective twistlocks.

A cabie is routed from the junction box to the actuator.

Cables are supported by clamps and plastic ties. Cables routed along the structural longitudinal beams are routed in metal channel wireways for protection.

Electrical Actuator

The twistlock actuator is a Plessey part number OM422M12: a 400-Hz, three-phase, 120/208V unit with an output of 250 in.-lb at 13 rpm, resulting in a twistlock operation taking about 1 sec.

Microswitch Assemblies

All sensing switches are roller actuated miniature type having two single-pole double throw circuits. These switches are used to provide twistlock position indication, twistlock actuator limits, and down/flush sensing. In all applications the switch is preassembled to a mounting plate (Figure 11), and the switch actuator position is adjusted on installation by adjusting a shim stack (Figures 12 and 13). There are 12 microswitches installed. Four (one for

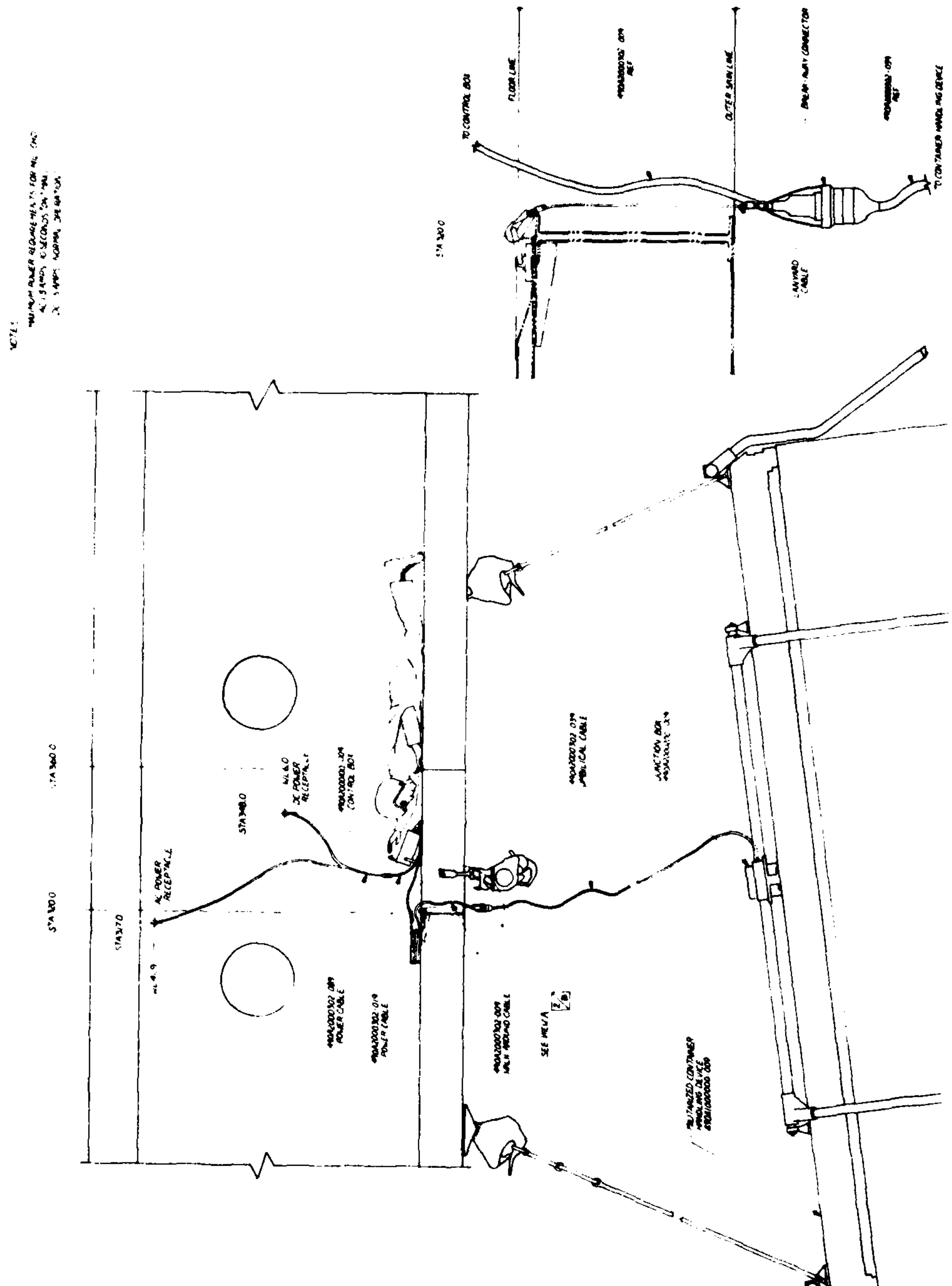


Figure 9. Breakaway Connector (CH-47 Helicopter Interface)

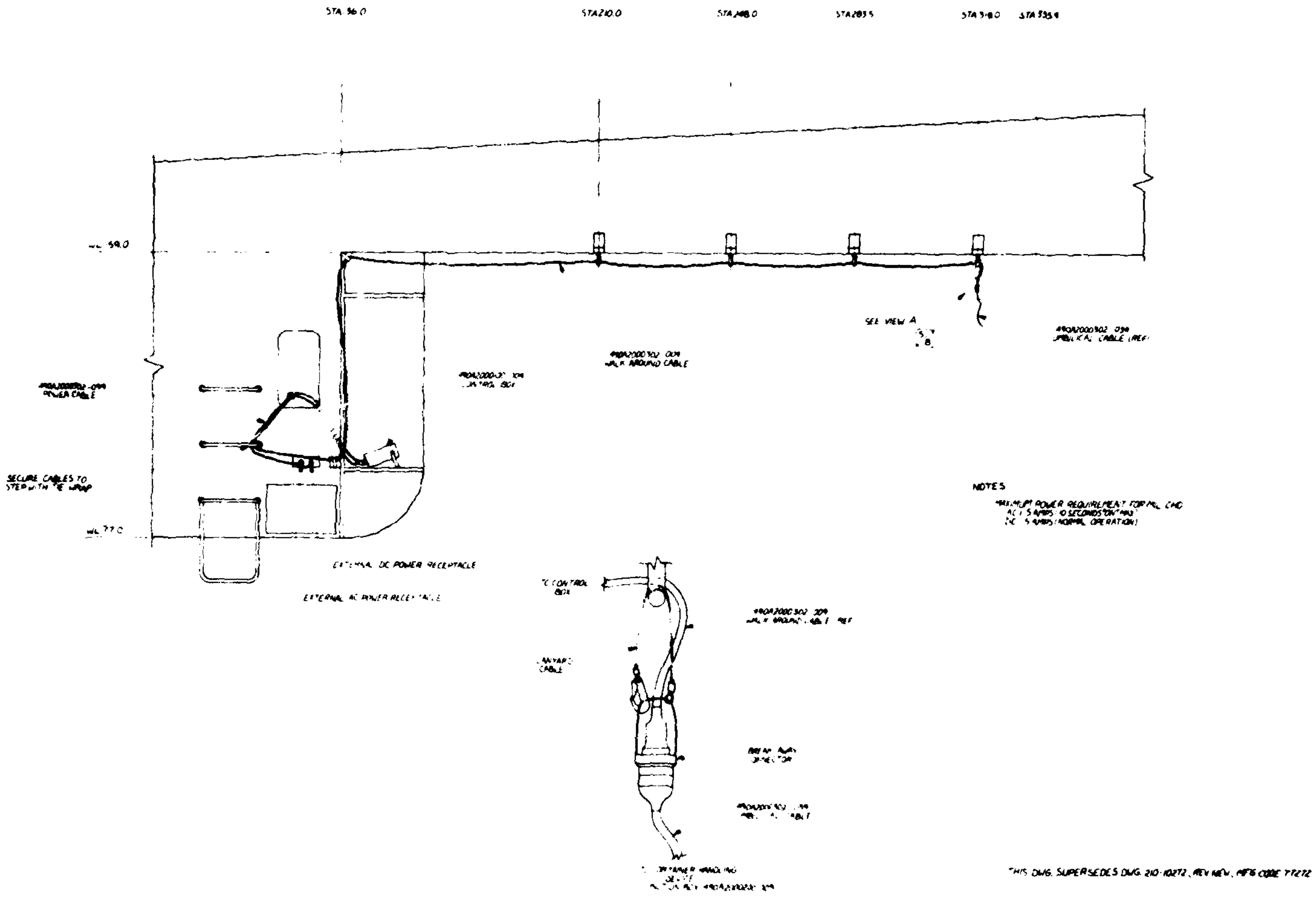


Figure 10. Breakaway Connector (CH-54 Helicopter Interface)

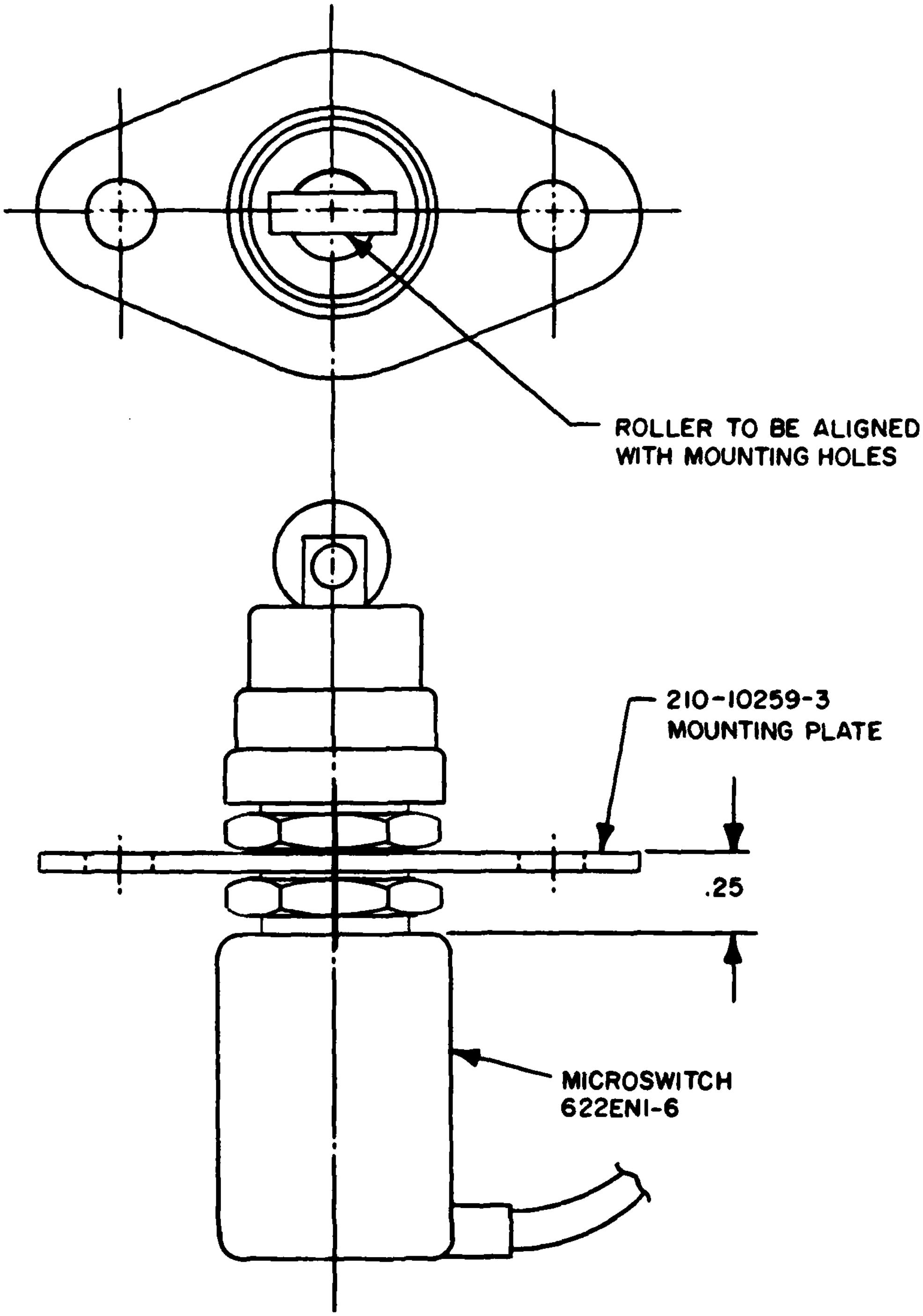


Figure 11. Microswitch and Mounting Plate Assembly

NOTE: "LOCKED" MICROSWITCH IS THE SWITCH
CLOSEST TO THE CORNER INTERLOCK
PLUNGER. TYPICAL ALL CORNERS

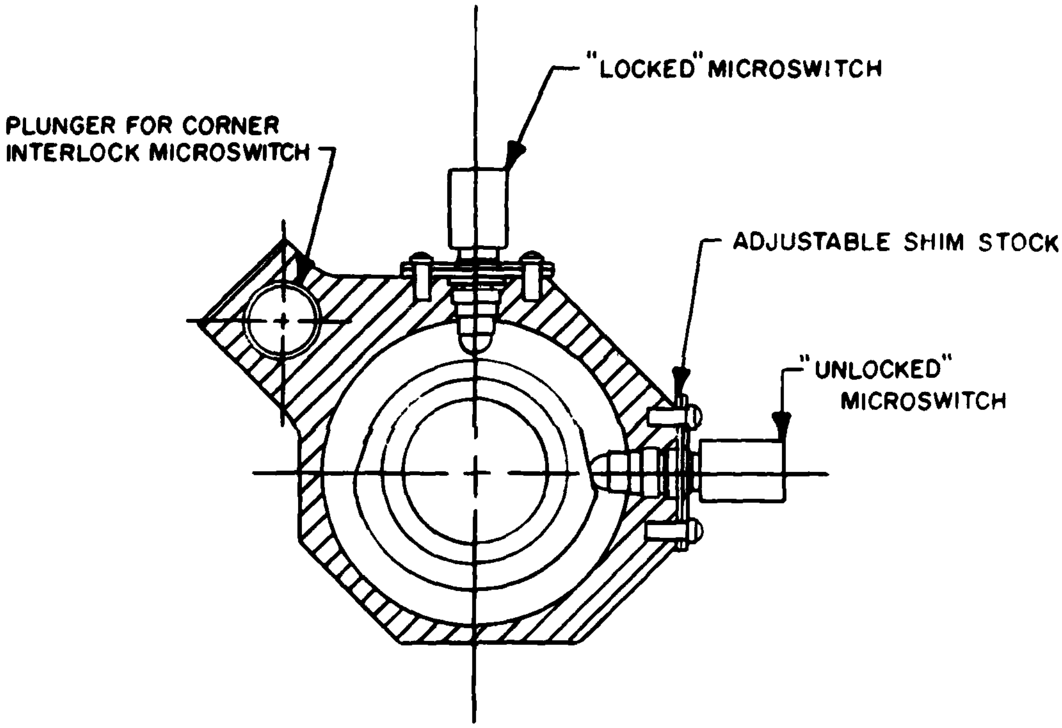


Figure 12. Location of Twistlock Switches

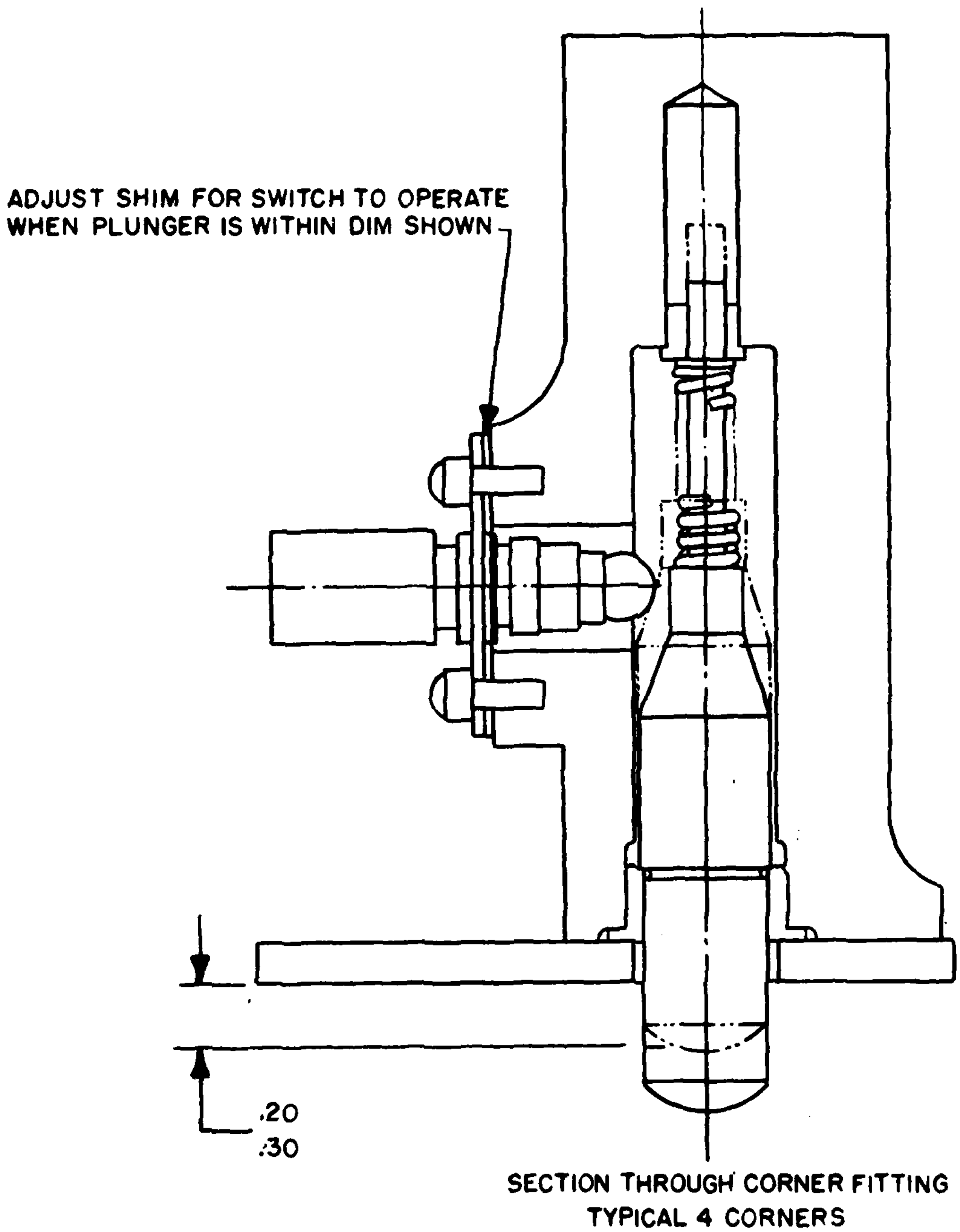


Figure 13. Corner Interlock Switch Adjustment

each twistlock) indicate twistlock "locked" condition. Four (one for each twistlock) indicate the twistlock "unlocked" condition (Figure 12), and four (one for each twistlock) indicate whether the CLAH is "down" or "not down" on the MILVAN (Figure 13).

The electric actuator does not have built-in limit switches; the twistlock microswitches provide the limit switching.

STRUCTURE

The structure consists of a box beam frame of 8- x 20-foot planform and six guide tubes designed to center the CLAH frame on the MILVAN/container.

Structure Frame Construction

The structure is a rectangular frame conforming to the planform of a standard 8- x 8- x 20-foot container. It is made up of box beams (Figure 14) and corner fittings. The vertical panels of the box beams are aluminum metal-to-metal bonded structures consisting of top and bottom 90^{o} angle extrusions with a pair of sheet panels bonded simultaneously to the angles and to each side of a honeycomb core. A pair of cap sheets riveted to the top and bottom angles complete the box beam. The side beams and the end beams are riveted to the corner fittings. The side beams are braced at their mid points by a pair of panels (bonded angles, sheets and honeycomb core) bridging from one side box beam to the other. A bracket riveted to the mid points of this pair of panels serves as anchor point for four bracing tie-rods that go to the four corners of the frame, providing strength and stiffness for horizontal racking loads.

Guide System

The function of the guide system is to funnel the frame into position as it is lowered onto the container, such that the twistlocks will engage the fittings at the four corners of the container. The principal parts of the system are the six flared tubes, with two mounted on each side beam and one mounted on each end beam of the structure. The flared tube is mounted, at right angles, on the end of a torque tube. The torque tube, in turn, is supported between a bearing pillow block and a fixture. Quick-disconnect pins at the fixture provide for orienting the flared tubes in stowed position (pointing up) or in operational position (pointing down). When in the operational position the 18-inch flare on each guide tube gives the helicopter pilot a 1½-foot tolerance on the accuracy with which he must lower the CLAH onto the container, in order to successfully engage the twistlocks.

The guide tube and torque tubes are designed as springs to absorb the impacts caused by the guides striking the container during acquisition. If impact loads above those for which the system is designed are experienced, the guide tube is designed to fail at a lower load than the remainder of the system. A damaged or broken guide can be easily unbolted and replaced.

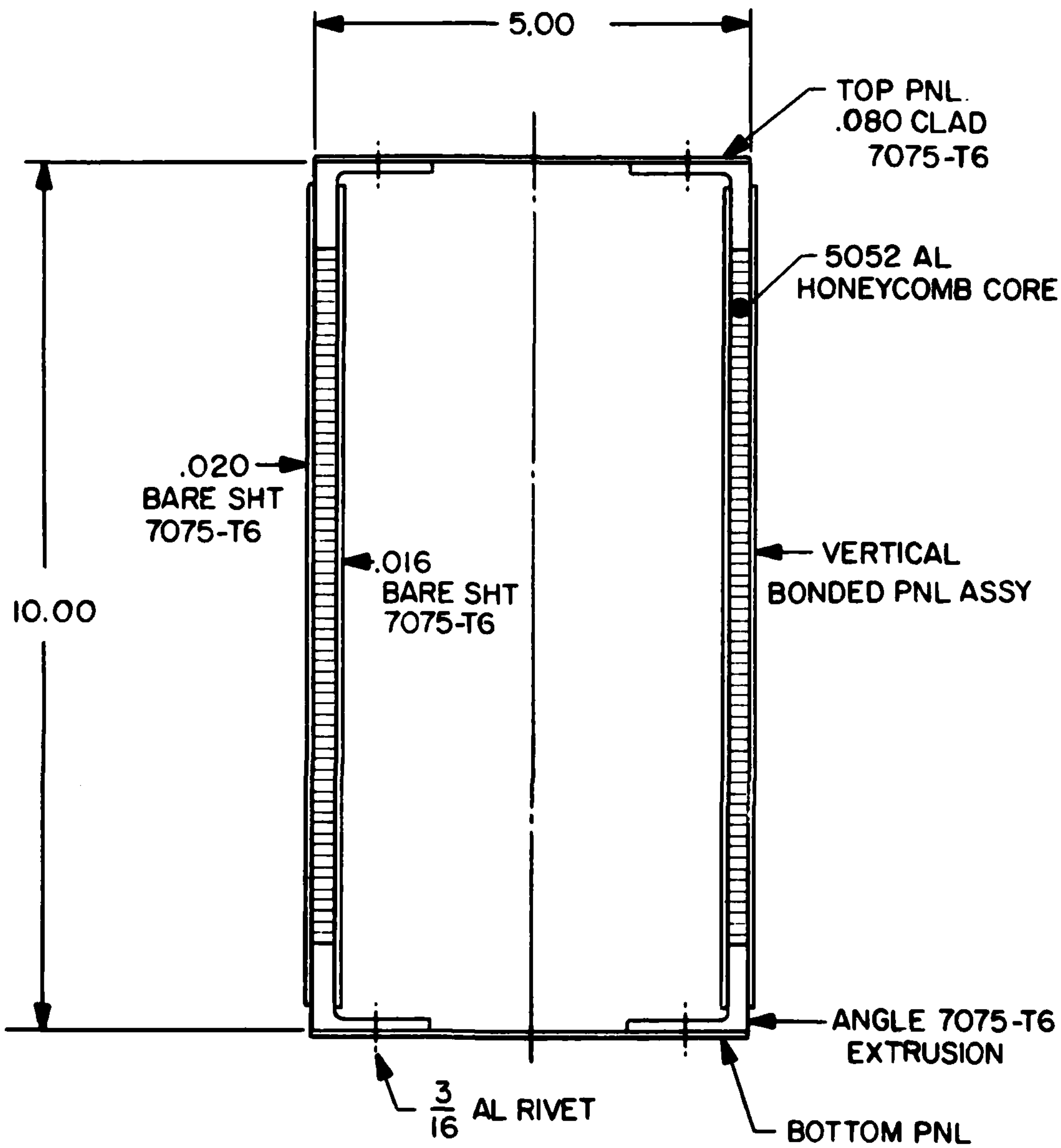


Figure 14. Typical Box Beam

The free end of each guide tube contains a plug fitting which houses a spherical ball-roller. The roller allows the CLAH to translate across the top of a container if the guide is placed on top of the container rather than over the side.

It is anticipated that pilot proficiency in the container acquisition mission may eventually lead to a desire to shorten the guides. The tubular configuration of the guide and the design of the guide foot allow the tube to be cut and drilled and the foot to be rebolted at the shortened location without difficulty.

MECHANICAL SYSTEM

The twistlock actuator powers the twistlocks through a series of bell cranks, push rods, sprockets, and link chains. Provision is made for manual operation of the twist for check-out purposes and for the emergency case of electrical failure.

Sling attachment fittings are provided on the four corners to permit dual invert "v" sling attachment to fore and aft hooks on the helicopter.

Twistlock System

The mechanical linkage of push rods, bell cranks, sprockets, and link chains must first be set up to synchronize all twistlock hammerheads to be in line with the CLAH axis for the unlocked position, and at right angles thereto for the locked position (Figure 15). The sprocket/cam that mates with the twistlock fitting is supplied two key slots. This requires the use of the right key slot to orient the cam as illustrated in Figure 12 while synchronizing the twistlock fittings. The limits within which the twistlocks must be aligned are shown in Figure 16.

There are two microswitches at each twistlock location—one to operate when the system is in the unlocked position; the other to operate when the system is in the locked position. The twistlock switches provide two services: status indication at the control box and limit travel of the actuator. The indication at the control box depends on all twistlocks being in the selected position before the indicator will light.

With the twistlocks in the unlocked position (longitudinal axis of the twistlock hammer-heads in line with the longitudinal axis of the CLAH) the unlocked microswitches at all four corners must be adjusted to just actuate (Figure 12). A shim stack is provided to make the adjustment. Similar adjustments are made for the locked position.

Down/Not Down Interlock System

The corner interlock system is wired to ensure that the twistlocks will not actuate to lock unless the CLAH is fully down and correctly positioned on the container at all four corners, and will not actuate to unlock unless the load is supported on the ground. When the CLAH

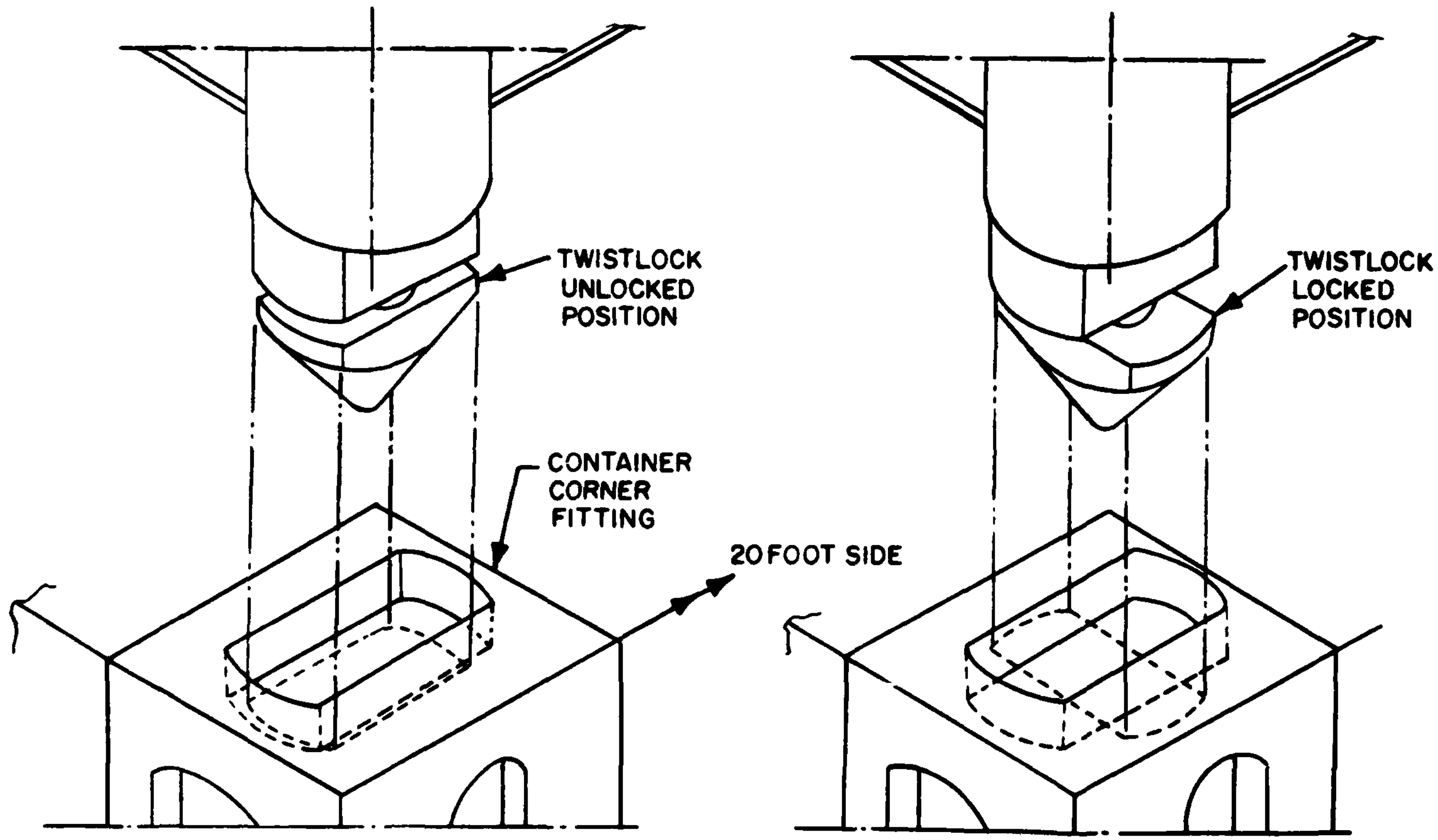


Figure 15. Schematic of Twistlock Operation

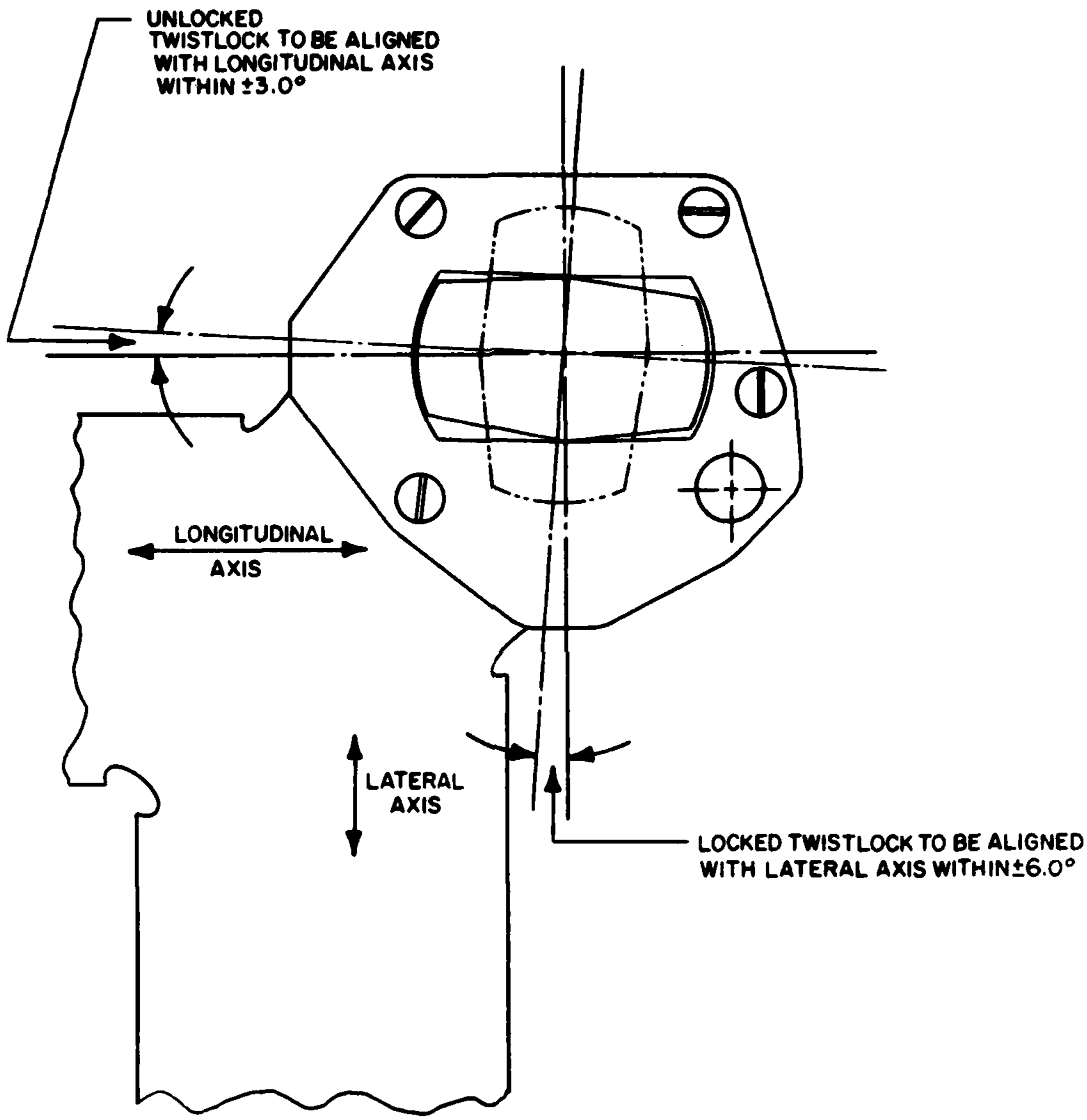


Figure 16. Twistlock Alignment Limits

is fully down, the plunger (Figure 13) is fully depressed and completes the "lock" circuit. When the load is suspended from the CLAH as in flight, the clearance between the twistlocks and the load corner fittings causes the plunger to partially extend, which opens the switch, disabling the actuator until the load is securely on the ground. The four plunger activated switches are wired in series to ensure that all corners are down before the twistlocks can move. The adjustment of the microswitch installation to indicate whether all four twistlocks are "down," ready for locking, or are "not down" is illustrated by Figure 13.

Manual Twistlock Operation

Provision for manual operation is made to permit checking out and adjusting the mechanical system or unlocking and disengaging the CLAH from the container in the event of an electrical failure.

When power is off, the motor drive shaft is fixed to the motor housing by the motor (magnetic) brake. A manual lever (Figure 17) is provided to turn the motor housing, in the power-off condition, and thus the twistlocks. The lever is placed in the mid position for electrical operation secured by a quick-release pin. By removing the pin, the lever can be rotated from its original position to its extreme position in the only direction it will move (in one direction if moving from locked to unlocked condition, and in the opposite direction if moving from unlocked to locked condition). The manual release lever must be returned to its vertical position and the quick-release pin reinstalled in the center location before the system can again be operated electrically. Manual release force should not exceed 20 pounds measured at the top of the lever. Higher forces indicate excessive binding in the mechanical linkage system.

THE LEVER HANDLE LOCK PIN MUST BE
INSTALLED THRU THE CENTER HOLE PRIOR
TO ELECTRICAL TWISTLOCK OPERATION.

A decal caution note is posted on the CLAH frame immediately below the manual lever. Failure to observe this caution will result in cracking the motor mount, as the motor will attempt to drive the bell crank (attached to the motor shaft) beyond the limits of the opening in the motor mount.

Sling Attachment Fittings

The four 210-10222 lift fittings are bolted to the CLAH corner fittings with four ½-inch-diameter bolts to each fitting. A two-lug shackle (210-10223) is hinged to each lift fitting with a 5/8-inch-diameter bolt giving four shear areas to transmit the load from each corner. A 15/16-inch-diameter hole is provided in the shackle for attachment of the sling.

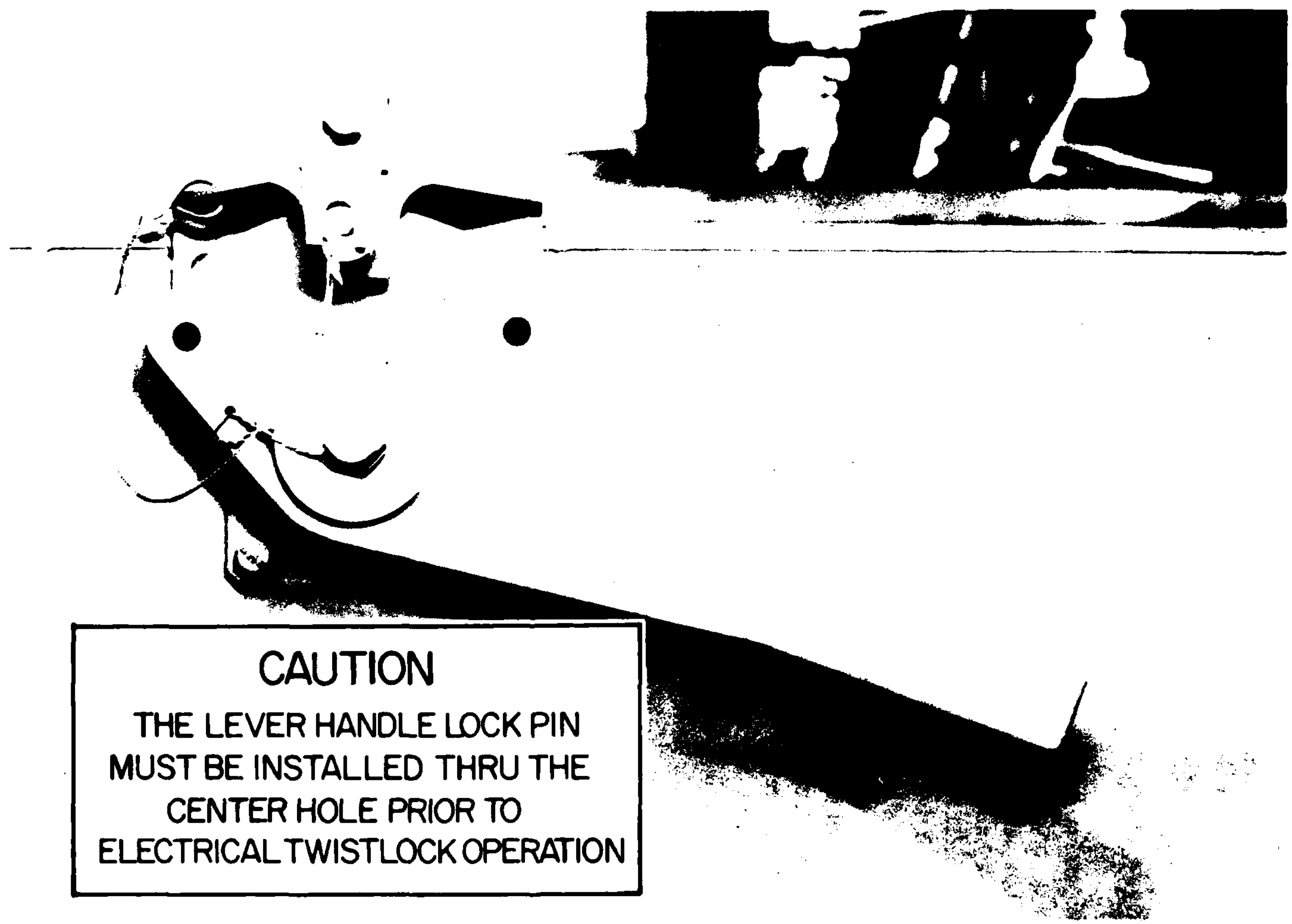


Figure 17. Manual Lever

CLAH OPERATION

The CLAH suspended under either the CH-47 or the CH-54 helicopter is designed to acquire, pick up, transport, and deposit a MILVAN or commercial ANSI/-ISO container without the assistance of ground crew.

SYSTEM OPERATION

The control box, umbilical cord, and the walk-around power cable are removed from the CLAH stowage box and placed aboard the helicopter. Utilizing the lanyard hook attached to the control box handle, the crewman secures the control box to the aircraft. He then attaches the power cable and the umbilical cord to the control box. The walk-around power cable is then routed to and connected to the onboard power receptacle outlets. The aircraft is oriented relative to the CLAH such that forward on the aircraft matches "FWD" marked on the CLAH. This ensures the correct sling lengths for load attitude. With the aircraft in hover, the slings from the CLAH are engaged with the aircraft hooks. The umbilical cable is lowered from the aircraft and connected to the junction box. The CLAH will have the fixed guide arms extended when on the ground, eliminating the need for any support equipment. The helicopter will now lift the CLAH clear of the ground. The crewman checks to ensure that the AC and DC power cables from the control box are connected to the appropriate outlets and that the twistlock switch is in the "unlocked" position. The power switch is now switched "on" and the DC and AC indicators will light. Also, the corner interlock indicator "not down" and twistlock "unlocked" indicator will light. (The circuit design includes an interlock such that the twistlocks cannot operate until the corner down switches all indicate the CLAH is correctly positioned over the load. This is to ensure that the twistlocks are always correctly aligned to engage with the container receptacles.) To check the twistlock functioning, the crewman may override the interlock by pressing and maintaining the corner interlock "down" indicator lamp and selecting twistlock "locked". The twistlock "unlocked" indication will immediately go out and the "locked" indicator will light within approximately 1 second. If the "locked" indicator does not light there is a malfunction of the twistlock system that must be corrected before the mission can be continued. On having a satisfactory "locked" indication, the twistlock switch must be returned to the "unlocked" position while maintaining the press-to-test switch of the corner interlock "down" indicator lamp. When the "unlocked" indicator is lit, the system is now ready for use. The crewman may check the integrity of the four indicator lights in the control panel after power is "on" by pressing the twistlock "locked" light. The press-to-test contacts of this indicator are wired to cause all four indicators to light.

PRESS-TO-TEST FOR INTEGRITY OF INDICATOR
LIGHTS BY PRESSING "LOCKED" BUTTON
ONLY WHEN TWISTLOCK SWITCH IS IN THE
"UNLOCKED" POSITION.

WHEN ALL PREPARATIONS AND CHECKS HAVE BEEN COMPLETED, GROUND CREW SHALL CLEAR THE AREA AND SIGNAL THE FLIGHT CREW TO PROCEED WTIH THEIR MISSION.

While approaching the load, the twistlock "lock" position will be selected. (Note: The twistlocks will not actuate at this time due to the corner "down" interlock feature. However, selecting "lock" at this time ensures the fastest acquisition upon correct CLAH/load positioning.) When over the load, the aircraft will descend until the guides are positioned correctly and the CLAH rests on the load. At this time the corner interlock "down" switch will light and the twistlock status lights change from "unlocked" to "locked" automatically.

The load may now be flown to the desired location. Upon lift-off, the corner interlock light will change from "down" to "not down". On approaching the deposit zone, the crewman will select twistlock "unlock," the interlock system preventing the twistlocks from operating until the load is on the ground. Immediately after the load is on the ground, the corner interlock lights will change from "not down" to "down" and the twistlock status lights will change from "locked" to "unlocked". When the "unlock" selection has been made prior to the load touching the ground as described above, the system acts as an automatic touchdown release and ensures minimum deposit times.

If there is no requirement for very rapid turnaround and a more precise positioning is required, then the twistlock "unlock" selection should not be made until the load is in the desired position and the corner interlock "down" indicator is lit.

Upon release of the load, the helicopter will lift off to acquire further loads or return to base.

The crew member maintains clear intercom contact with the pilot at all times during the approach, hook-up, and release. The pilot ensures adequate clearance between the CLAH and the container during approach and hover until the flight engineer or pilot can see the container. The crew member then acts as signalman and operator for CLAH hook-up to the container, etc.

OPERATIONAL CRITERIA

Container – CLAH will interface with an 8- x 8- x 20- ft MILVAN or commercial ANSI/-150 container.

Max. gross weight – Based on 60/40 weight distribution, the CLAH is designed to lift and transport a payload of 33,300 lbs maximum (container weight + content weight).

IN ACTUAL USE THE MAXIMUM GROSS WEIGHT IS LIMITED TO THE LIFTING CAPACITY OF THE HELICOPTER, THE ADJUSTED SLING ASSEMBLY CAPACITY LIMIT OR THE 33,300-LBS CLAH LIMIT, WHICHEVER IS LEAST.

Electrical power required – 28 VDC, 1.0 amp
208 VAC, 3Ø, 400 Hz, 1.0 amp

CLAH weight – 895 lbs.

Helicopter electrical – CH-47 – cables (W292) 490A2000302-019 and power interface (control box to on-board power receptacle) (W247) 490A2000302-089 both required.
CH-54 – cable (W254) 490A2000302-099 is required.

Sling requirement – Army 25,000-lb-capacity four-legged adjustable sling assembly.

SLING/HELICOPTER INTERFACE

Test Sling Requirement

An Army 25,000-lb-capacity four-legged adjustable sling is the primary rig used for testing (Figure 18). For greater stability in forward flight a two-point suspension with two inverted "V" slings are used to transport 8- x 8- x 20- ft containers. The four-legged sling is split into two two-legged slings, with a single apex fitting for each. The braided nylon rope legs of the sling are approximately 1½ in. in diameter and 12 ft long. A loop of the braided rope is formed on each end. In each of the lower loops is installed a grab-hook and a 16-ft or 20-ft length of chain. The longer of the two-legged slings is attached to the forward pair of CLAH shackles, and the shorter to the aft pair. Attachment is made by looping the chain through the CLAH shackle and securing it in the grab hook at the length required. The chain is held in position by the locking action of the links on either side of the hook slot and is retained in the hook by a spring loaded keeper. For proper load attitude, the forward sling assembly is adjusted to be 2 ft longer than the aft sling assembly (Figure 19).

THE RATED WORKING LOAD ON EACH LEG OF THIS SLING ASSEMBLY IS 6250 LBS. WHEN ADJUSTING THE LENGTH, THE CHAIN MUST BE DOUBLED AND SECURED TO THE GRAB HOOK IN ORDER TO MAINTAIN THE WORKING LOAD.

Figure 18. Four-Legged Adjustable Sling

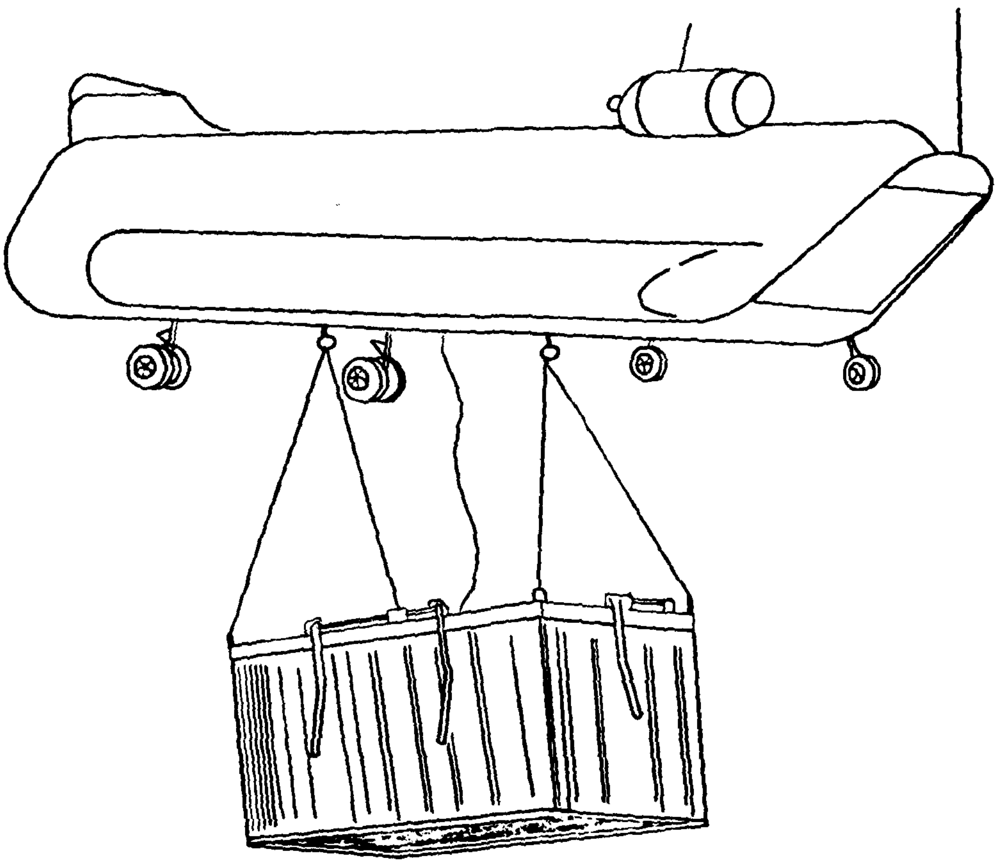


Figure 19. CH-47D With CLAH and MILVAN Suspended by Inverted Sling

CH-47 Dual Hookup Installation

The preferred method of hooking up the CLAH to the aircraft is to have the CH-47 park parallel with the CLAH, with the nose of the aircraft pointed in the same direction as the "FWD" end of the CLAH, with a clearance of 9 feet or less between the side of the helicopter and the CLAH. The crewman can then connect the apex fitting of the inverted "V" slings with their respective hooks more readily than with the helicopter in a hover. The umbilical cable is lowered through the hatch and connected with the CLAH junction box. After the hook-up is complete, the ground crew shall vacate the area and signal the helicopter pilot to lift the CLAH. The aircraft may then proceed on its mission.

At the completion of the mission and on returning the CLAH to base, the helicopter is brought to a hover, the CLAH is lowered to contact the ground, and the helicopter is maneuvered to a landing beside the CLAH.

IN DEPOSITING THE CLAH ON THE GROUND AFTER MISSION COMPLETION, CARE MUST BE TAKEN NOT TO DAMAGE ELEMENTS OF THE CLAH WITH THE HEAVY CHAINS OF THE SLINGS. BRING THE GUIDE LEGS IN HOVERING CONTACT WITH THE GROUND; ENSURE ADEQUATE SLACK IN THE SLING AND MANEUVER THE HELICOPTER TO THE SIDE, LANDING PARALLEL WITH THE CLAH.

The slings may then be unhooked from the helicopter and the umbilical cable disconnected from the junction box.

The control box, umbilical cable and the walk-around power cable may then be removed from the aircraft and stowed in the CLAH stowage box for future missions.

WHEN THE CLAH GUIDE TUBES ARE IN THE STOWED (UP) POSITION, DO NOT REST THE TWISTLOCKS ON THE GROUND. BLOCK UP THE CLAH ON ITS BEAMS OR PLACE A LOAD SPREADER UNDER EACH CORNER. THIS IS NECESSARY TO PREVENT CONTAMINATION OR DAMAGE TO THE TWISTLOCKS.

CH-54 Hookup Installation Procedure

In standard operations with the CH-54, the 25,000-lb test sling assembly is not used. The aircraft is brought to rest over the CLAH. The bifurcated end of the power cable is connected to the external AC and DC outlets on the outside left of the operator's cabin. The cable is secured to a step rung with a tie wrap and run through a hole inside the cabin to the control box. The umbilical cable is connected to the control box and run from the operator station to the cargo hook. The break-away connector is secured by the lanyard as shown in Figure 10 and the power umbilical cables are connected to the junction box. The forward lashing reel cables on the AC are extended to 10 ft-6 in., and the rear lashing cables on the AC are extended to 10 ft and are connected to the lift shackles on the respective corners of the CLAH. The CLAH is ready for flight.

When the container-transporting missions are completed and the CLAH is returned to base, the CH-54 is brought to rest over the CLAH. The lashing reel cables and the umbilical cable can then be disconnected.

UMBILICAL HOOKUP PROCEDURE

The umbilical cords for transmitting power to the CLAH and for transmitting signals to and from the CLAH are stored in the stowage box atop the CLAH (Figure 8).

CH-47 Helicopter Hookup

Reference Figure 3 for cable orientation.

The bifurcated end of the power cable No. 490A2000302-089 (W247) is plugged into the cabin AC and DC outlets at Station 317 and 348 respectively as shown in Figure 20. Cable No. 490A2000302-019 (W202) is then used to interconnect the bifurcated cable with the control box. Cable No. 490A2000302-009 (W201) is plugged into the control box and the lanyard on the breakaway fitting is hooked into a tiedown fitting adjacent to the central hatchway. The other half of the breakaway fitting is coupled on cable No. 490A2000302-039 (W1) in readiness for feeding through the hatchway to couple with the CLAH.

CH-54 Helicopter Hookup

Reference Figure 3 for cable orientation.

The bifurcated end of the power cable No. 490A2000302-099 (W254) is plugged into the external AC and DC outlets on the outside left of the operator's cabin (Figure 21). The cable is secured to a step rung with a tie wrap and run through a hole into the cabin to the control box (Figure 10). The No. 490A2000302-009 (W201) umbilical cable is connected to the control box and run from the operator station to the cargo hook (Figure 10). The breakaway connector is secured by the lanyard as shown in Figure 10. The other half of the breakaway fitting is coupled on cable No. 490A2000302-039 (W1) in readiness for coupling with the junction box atop the CLAH.

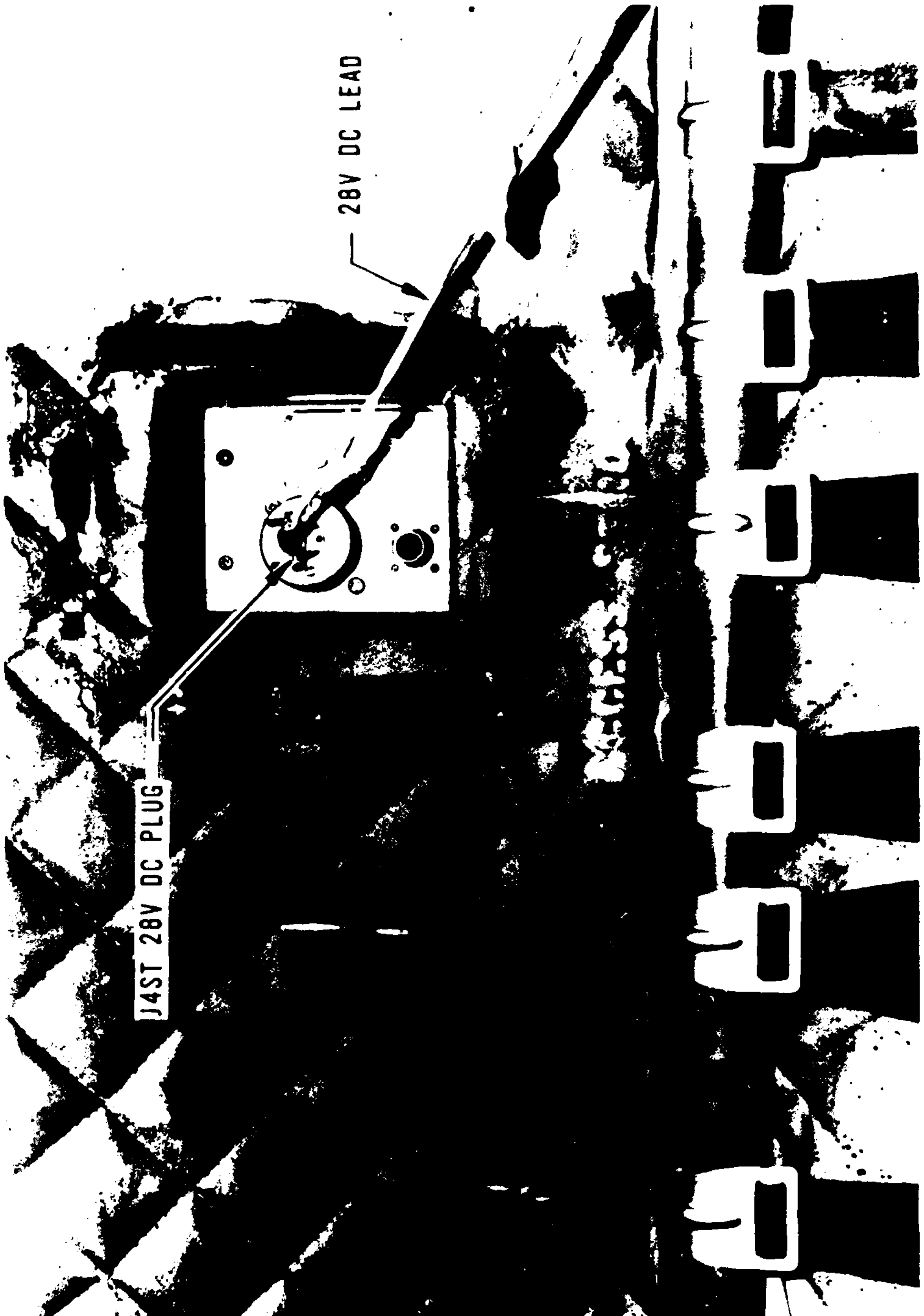


Figure 20. Electrical Hookup—CH-47

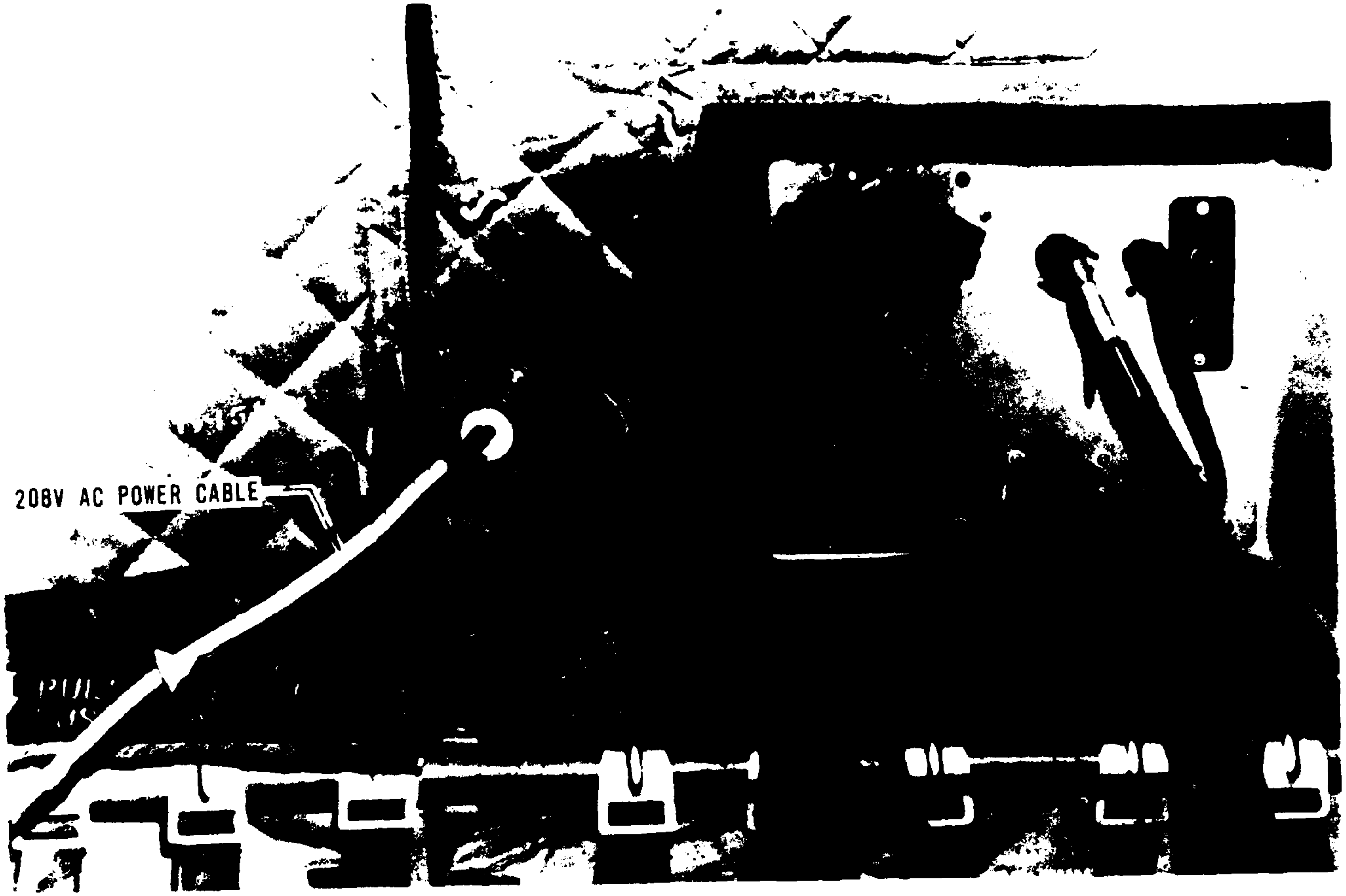


Figure 20. Continued

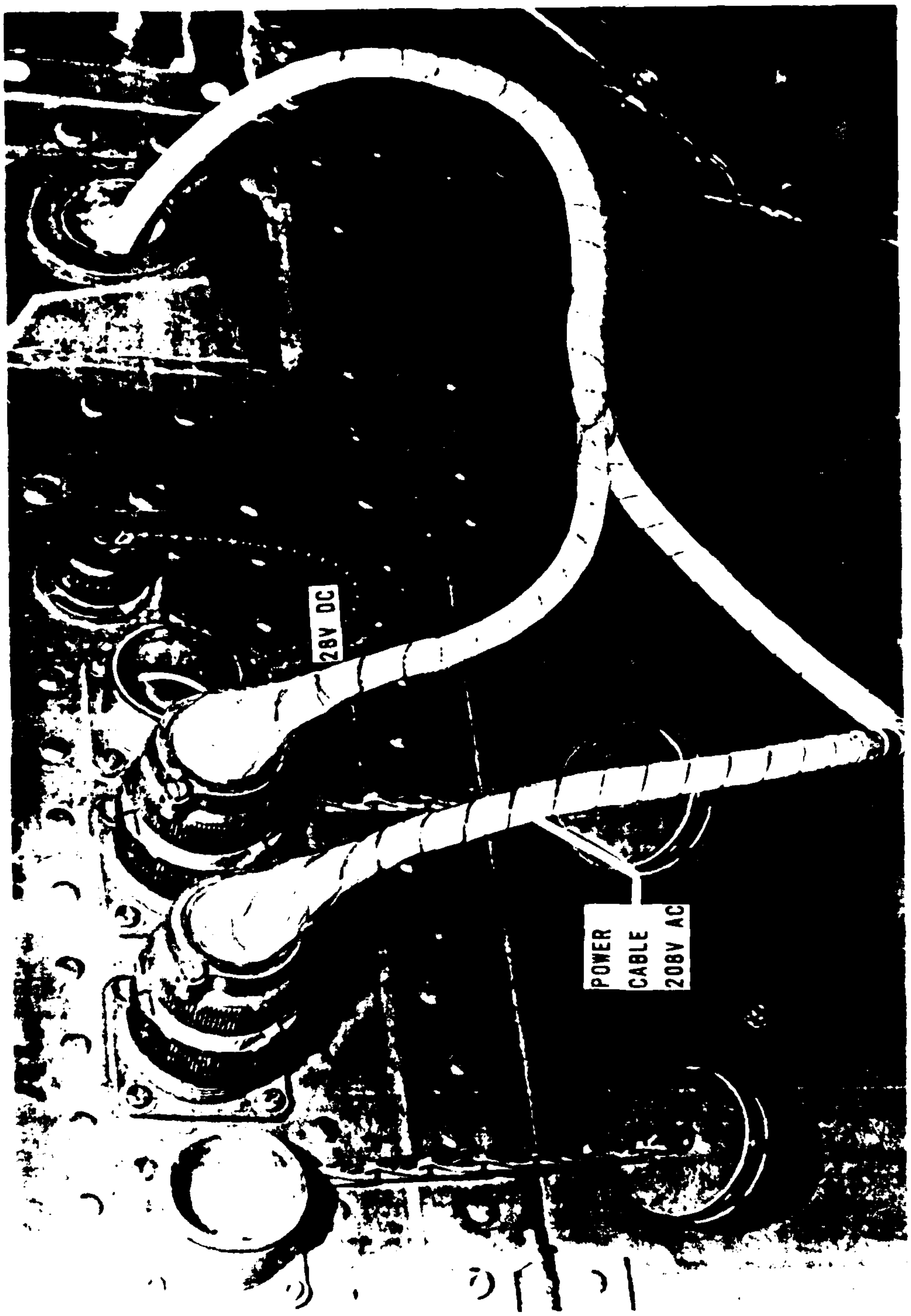


Figure 21. Electrical Hookup—CH-54

EMERGENCY RELEASE CONDITION

The container handling device does not have emergency release mechanisms within its own system design. When an emergency release is required, separation of both device and container must be executed by releasing the load of the helicopter hook(s).

STABILIZING LINES, IF ANY, SHALL BE SEVERED PRIOR TO RELEASE OF HELICOPTER CARGO HOOKS

TWISTLOCK AND INTERLOCK SYSTEM ADJUSTMENT

Requirements

The method for system adjustment was developed and verified during manufacture and checkout of CLAH units 1 and 2.

Subsequent maintenance, rework, and repair to the twistlock mechanical and electrical components that affect alignment will necessitate twistlock system readjustment to assure that the twistlock hammerheads fall within the allowable tolerance in the locked and unlocked positions as defined in Figure 16. If the mechanical system bell cranks, push-pull rods, sprocket/cams, chains, etc., are not aligned properly or the electrical locked and unlocked microswitches are not adjusted properly, the motor mount housing could be damaged by the bellcrank arm overtraveling and striking the mount. The electric motor actuator does not have built-in limit switches. Travel of the motor output shaft is controlled and limited by the corner locked or unlocked limit switches. The four locked or unlocked switches are wired in series to assure that all twistlocks are driven to the locked or unlocked position before the motor is electrically shut off and the motor brake is applied.

Adjustment Procedure

ALL MECHANICAL TWISTLOCK RIGGING MUST BE COMPLETED BEFORE STARTING ELECTRICAL SYSTEM LIMIT SWITCH ADJUSTMENTS.

1. Mechanical Twistlock Rigging Procedure

Position the four twistlock sprocket/cams, the four inboard bell crank/sprockets, the motor bell crank and the idler bell crank as noted in Figures 22, 23 and 24.

Align (rotate) the actuator motor output shaft keyway relative to the motor housing to rig the motor bell crank to the position defined in Figure 23. Subsequently, if the motor has been removed for rework or if a replacement motor is installed during field maintenance, it will be necessary to align the motor shaft to mate with the rigged bell crank.

Adjust the tension of the chain (at each corner twistlock) so that moderate finger pressure between the two chain runs at one end of the turnbuckle will result in approximately 0.25 inch of total deflection. Too much tension on the chain will make the twistlock hard to operate.

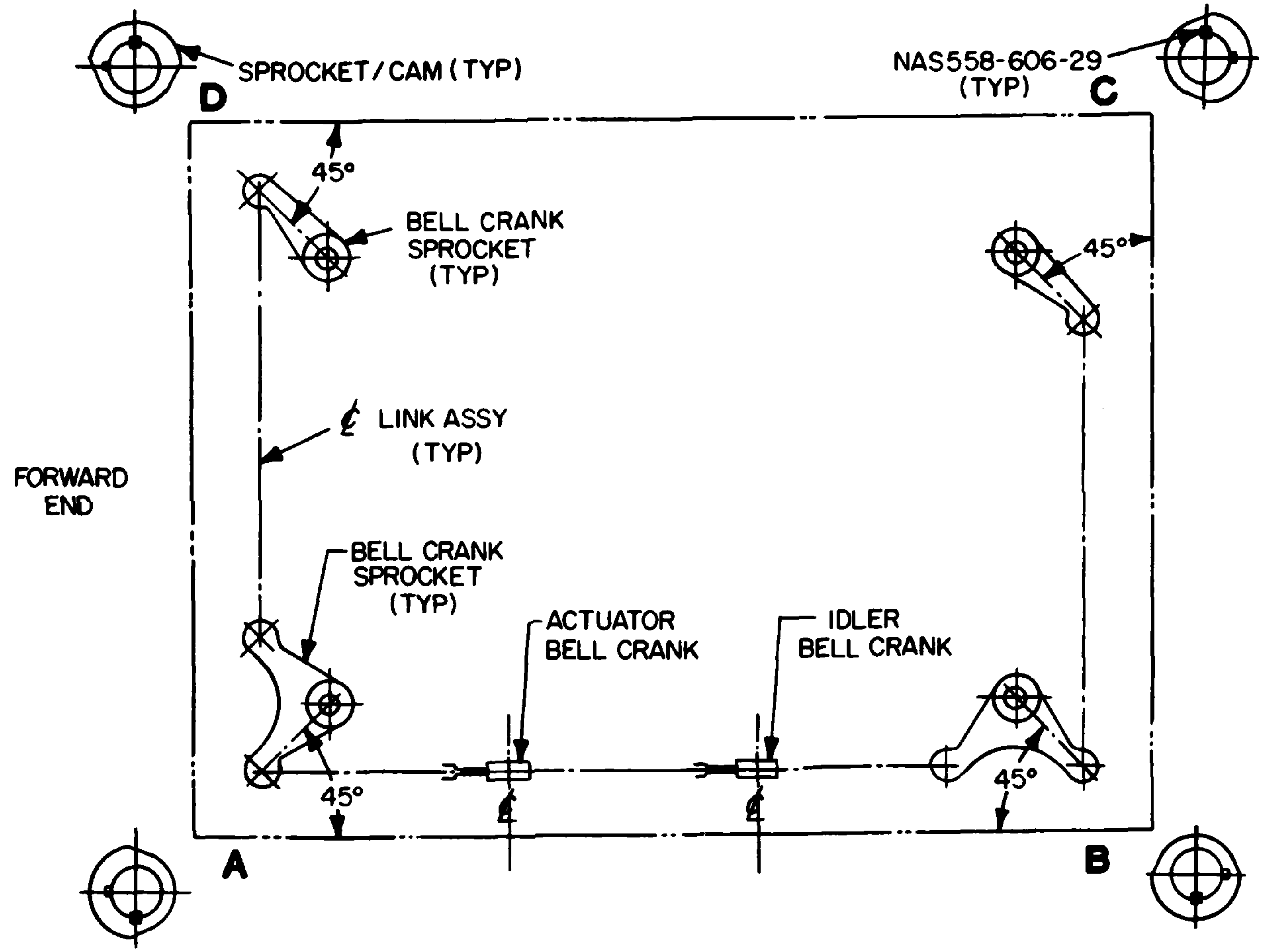


Figure 22. Rigging Orientation

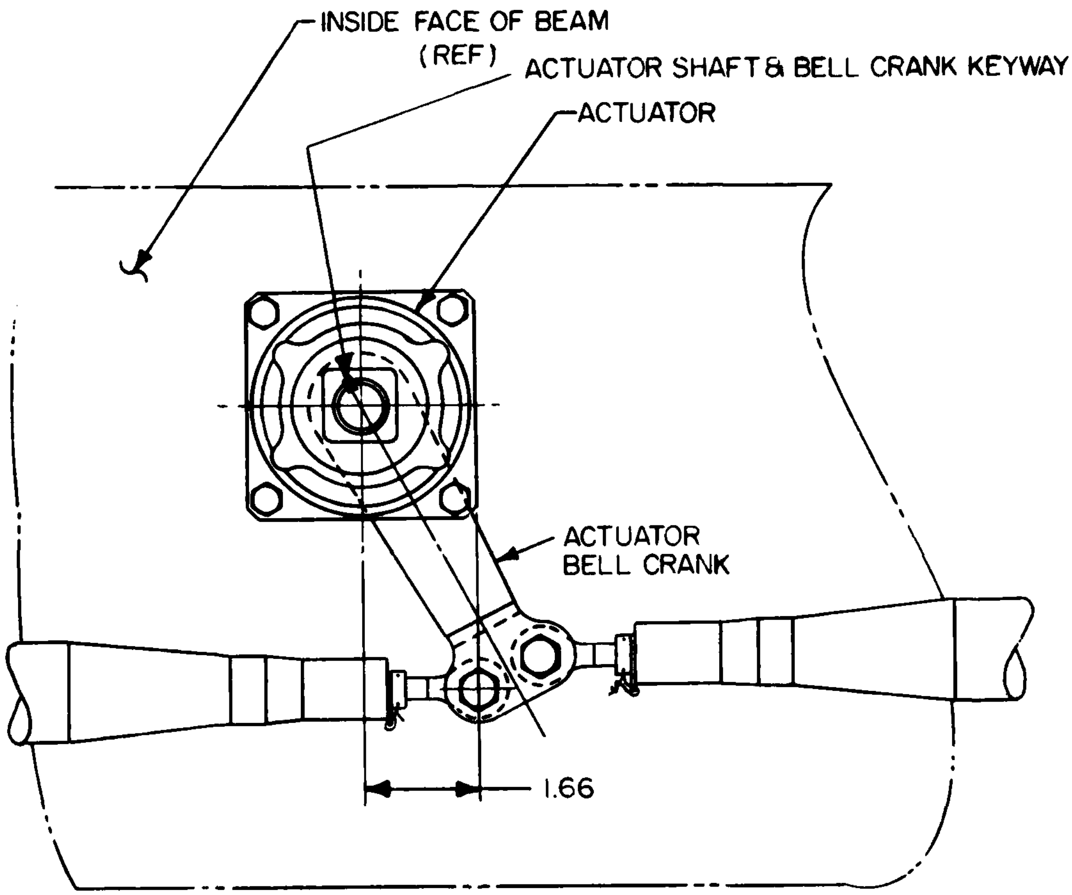


Figure 23. Actuator Bell Crank Rigging

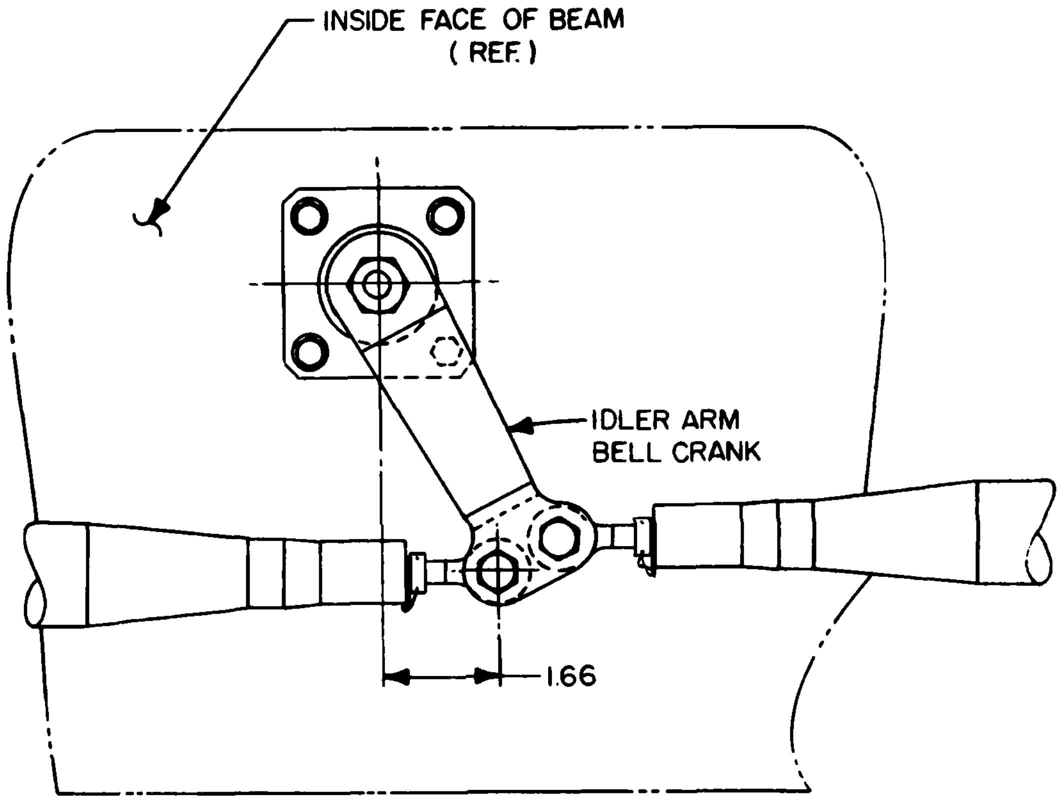


Figure 24. Idler Bell Crank Rigging

With the twistlock components rigged per above, adjust lengths of the push-pull rod assemblies to mate with and maintain the positioned components.

2. Electrical System Twistlock Limit Switch Adjustment Procedure

Assemble the umbilical cables W1 (490A2000302-039) and W202 (490A2000302-019) between the junction box and the control box. Assemble the walk-around cable W254 (490A2000302-099) to the control box; see Figure 3. Connect the AC and DC power connectors of this cable to a suitable power supply.

Ensure that the roller of all switches is aligned with the longitudinal centerline of the switch mounting plate and assembled per Figure 11.

KEEP HANDS AND OBJECTS CLEAR OF TWISTLOCK MECHANISM DURING OPERATION.

At corners A, B, C and D, position the twistlock in the unlocked position utilizing the manual lever. Adjust the thickness of the shim at all "unlocked" switches (see Figure 12) so that the switch just actuates when secured in place. Utilize the junction box indicator lights for each corner to determine switch actuation.

Position all the twistlocks in the locked position utilizing the manual lever. Adjust the thickness of the shim as required at all "locked" switches so that the switch just actuates when secured in place. Again, utilize junction box indicator lights to ascertain actuation.

3. Electrical System Interlock Switch Adjustment

At corners A, B, C and D, depress the interlock plunger until the end is .20 - .30 inch below the bottom of the fitting as shown in Figure 13 and maintain this position.

Adjust the thickness of the microswitch shim as required so that the switch just actuates when secured in place. Release the plungers.

The above requirements need not be accomplished simultaneously at corners A, B, C and D. Utilize the junction box indicator light for each corner to determine switch actuation.

Test Procedure

The system may now be functionally checked.

THE LEVER HANDLE LOCKPIN MUST BE INSTALLED THROUGH THE CENTER HOLE PRIOR TO ELECTRICAL TWISTLOCK OPERATION.

KEEP HANDS AND OBJECTS CLEAR OF TWIST-LOCK MECHANISM DURING OPERATION.

Using the control box, check as follows: Place the twistlock switch in the "unlocked" position. When the power switch is switched "on." the DC and AC indicators will light. Also the corner interlock indicator "Not Down" and the twistlock "Unlocked" indicator will light when the unlocked position is achieved and the twislock actuator stops the twist-lock within the limits shown on Figure 16. Select twistlocks "locked" while depressing the interlock bypass, and check to ensure that the "unlocked" indication is replaced by a "locked" indication on the control box. Check to ensure that the actuator stops the twist-locks within the limits shown on Figure 16. If necessary, readjust the microswitch shims to maintain these limits.

DESIGN CHANGE DESCRIPTION

PREPRODUCTION UNITS

Fabrication and assembly of preproduction CLAH units Serial Numbers 0001 and 0002, were in accordance with the engineering drawings, instructions. and specifications provided by the Government with the following exceptions as defined by the current contract:

1. The movable retraction capability of the alignment guide system was deleted.
2. The emergency jettison system was deleted.
3. An interlock system was added to ensure that the twistlocks will not actuate to close unless the CLAH is correctly positioned on the load or to open unless the load is supported on the ground.
4. The "Power On" indicator light circuit was modified for proper operation.

DELETION OF RETRACTION GUIDE SYSTEM (STRUCTURE/MECHANICAL)

Original design of the guide system included four (one mounted on each side of the CLAH structure) 210-10218-1 retraction gearbox assemblies, each driven by a motor actuator, to rotate the guide tubes from a downward (operational) position to an upward (retracted) position. This system was to enhance acquisition of a container from a cluster. Per contract requirement, this feature was deleted. Structure layouts were prepared to evaluate and establish a replacement system.

A torque tube lock fixture 490A1000001-001 was designed to replace the 210-10218-1 retraction drive assembly and associated actuator. This fixture (Figure 25) is physically interchangeable with the replaced unit; that is, it structurally accepts and supports the existing torque tubes and utilizes the existing mounting brackets, holes, and hardware for structural attachment to the box frame.

In addition, the fixture includes quick-release pins (Figure 25) to lock the guide tubes in the down (operational) position and to provide the capability of manually rotating and locking the tubes in the up (retracted) position. To reduce cost, the fixture was designed to accommodate either one or two torque tubes and eliminate the need for two different fittings. A mechanical stop was incorporated to prevent overtravel and to eliminate possible damage to the frame structure. Stress analysis was included in the overall design to assure that the replacement system met the original design requirements.

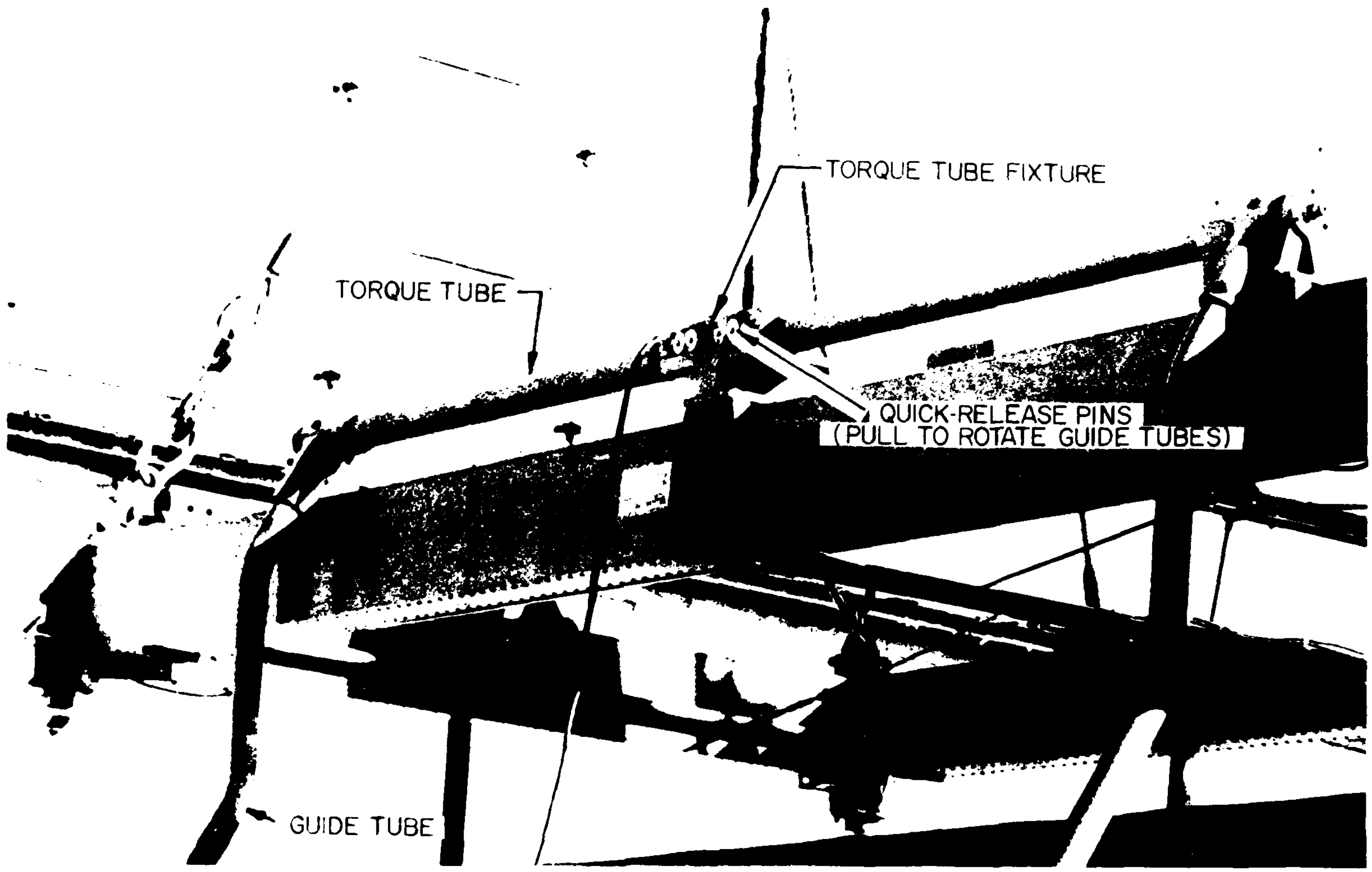


Figure 25. Torque Tube Lock Fixture

DELETION OF EMERGENCY JETTISON SYSTEM (ELECTROMECHANICAL)

Original design included a special jettison nut to retain each of the four twistlocks which secure the container to the CLAH. The jettison nut was to be actuated by the firing of a power cartridge installed within the nut. All four nuts were arranged to operate simultaneously when a jettison switch, located on the control box, was actuated by the crewman freeing the twistlocks and the container from the CLAH. This special nut was replaced with a standard MS21044N12 structural nut.

CONTROL BOX AND JUNCTION BOX (ELECTRICAL SYSTEM)

The original control box and junction box configuations were modified due to the deletion of the components, circuitry, and hardware associated with the movable retraction guide system and the jettison system.

INTERLOCK SYSTEM AND "POWER ON" INDICATOR LIGHT

The new control box configuration includes the addition of an electrical interlock system and a modification to the "Power On" indicator light circuit. The original circuit was modified and a relay was added to ensure that the twistlocks will not actuate to close unless the CLAH is correctly positioned on the load or to open unless the load is supported on the ground. A resistor was added to the "Power On" indicator light circuit to eliminate bulb failure.

DESIGN REVIEW

All Government-furnished drawings, instructions, and specifications were reviewed by engineering prior to release for fabrication to assess and verify their suitability for fabrication. Dimensional errors, incorrect material callout, hardware discrepancies, etc., affecting form, fit, and function were corrected on the drawing originals.

Drawings

New drawings were prepared as required to incorporate the CLAH design changes to the structure and electrical drawings. Drawings were prepared in accordance with MIL-D-1000, Form 2 requirements. The remaining CLAH drawings, which were not affected by the "CLAH Design Changes," were reviewed to determine if they met the latest MIL-D-1000, Form 2 and MIL-STD-100 requirements. These drawings were updated as necessary. Drawing changes relative to review for suitability for fabrication, and changes necessitated due to discrepancies found during manufacture and assembly of the CLAH were incorporated prior to submitting the drawing originals to the customer.

CONFIGURATION

Design of the CLAH consists of two major breakdowns–structure and electrical. The structure consists of the structural assembly, the guide installation, and the twistlock installation. The electrical consists of the control box, junction box, stowage box, microswitches and associated cabling. A generation breakdown is provided in Figure 26 defining the detailed parts, assemblies, and installations which make up each major section. Table 1 lists fabricated and purchased parts for the structure, guide, and twistlock installations. Table 2 lists fabricated and purchased parts for the electrical installation. Attaching hardware is called out in the applicable drawings.

The junction box was not down-sized with the removal of the movable retraction guide system components and the emergency jettison system components to allow for future design changes resulting from field test evaluation. Additional modules have been provided in the terminal junction system for such changes.

WEIGHT

The calculated weight of the original CLAH design with movable guide tubes and jettison system was 1002.2 lbs. The actual weight of the current configuration is 895 lbs (CLAH Serial No. 0001 weighs 894.4 lbs and CLAH Serial No. 0002 weighs 895.6 lbs).

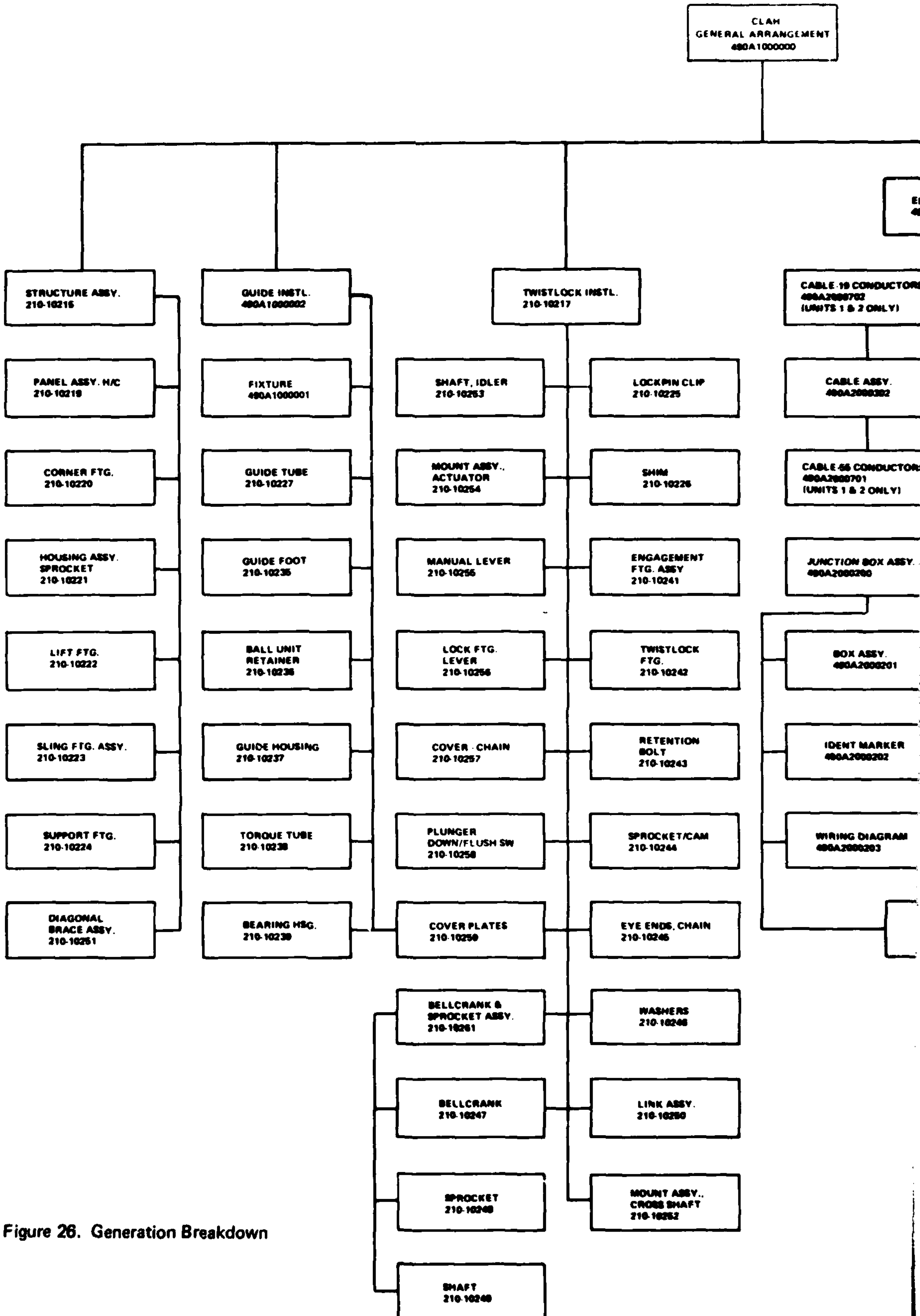
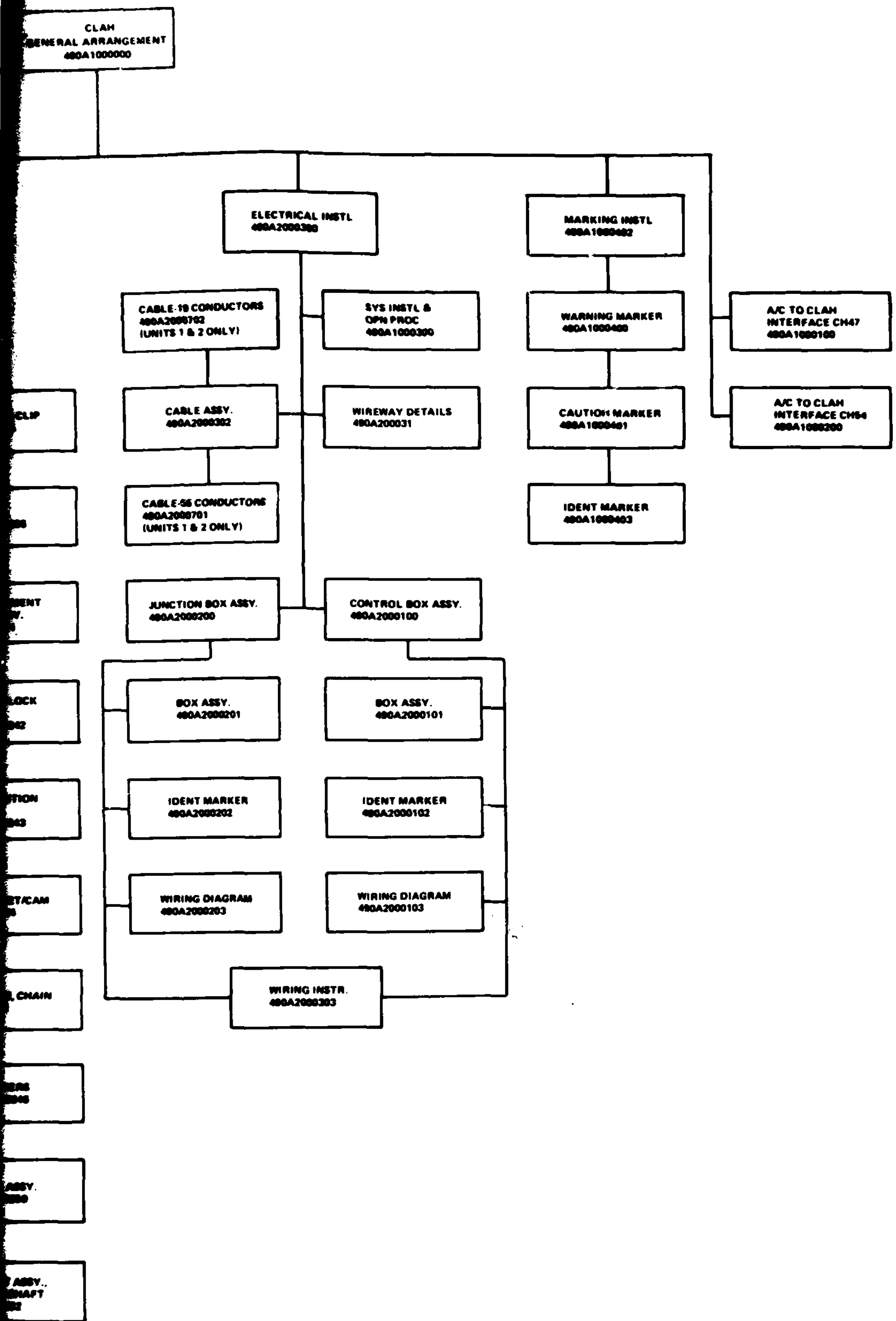


Figure 26. Generation Breakdown


CLAH GENERAL ARRANGEMENT 490A1000000
ELECTRICAL INSTL 490A2000300
MARKING INSTL 490A1000402
CABLE-19 CONDUCTORS 490A2000702 (UNITS 1 & 2 ONLY)
SYS INSTL & OPN PROC 490A1000300
WARNING MARKER 490A1000400
A/C TO CLAH INTERFACE CH47 490A1000100
CABLE ASSY. 490A2000302
WIREWAY DETAILS 490A200031
CAUTION MARKER 490A1000401
A/C TO CLAH INTERFACE CH54 490A1000200
CABLE-56 CONDUCTORS 490A2000701 (UNITS 1 & 2 ONLY)
IDENT MARKER 490A1000403
JUNCTION BOX ASSY. 490A2000200
CONTROL BOX ASSY. 490A2000100
BOX ASSY. 490A2000201
BOX ASSY. 490A2000101
IDENT MARKER 490A2000202
IDENT MARKER 490A2000102
WIRING DIAGRAM 490A2000203
WIRING DIAGRAM 490A2000103
WIRING INSTR. 490A2000303

2

TABLE 1–CLAH PARTS LIST

STRUCTURE, GUIDE & TWISTLOCK INSTALLATIONS

PART NUMBER	DESCRIPTION	QTY PER CLAH	USING ASSY DWG REF
210-10215-1	Structure Assy	1	490A1000000
210-10215-2	Upper Cap–Side	4	210-10215
210-10215-3	Lower Cap–Side	4	210-10215
210-10215-4	Upper Cap–End	2	210-10215
210-10215-5	Lower Cap–End	2	210-10215
210-10215-6	Gusset	4	210-10215
210-10215-7	Filler	8	210-10215
210-10215-8	Bracket	1	210-10215
210-10215-9	Bracket	4	210-10215
210-10215-10	Filler	8	210-10215
210-10215-11	Former	4	210-10215
210-10215-12	Clip	4	210-10215
210-10219-1	Panel Assy	2	210-10215
210-10219-2	Panel Assy	2	210-10215
210-10219-3	Panel Assy	2	210-10215
210-10219-4	Panel Assy	2	210-10215
210-10219-23	Panel Assy	2	210-10215
210-10220-1	Corner Fitting	4	210-10215
210-10221-1	Housing Assy	4	210-10215
210-10222-1	Lifting Fitting	4	210-10215
210-10223-1	Sling Fitting	4	210-10215
210-10224-1	Support Fitting	2	210-10215
210-10224-2	Support Fitting	6	210-10215
210-10224-3	Support Fitting	12	210-10215
210-10251-1	Diagonal Brace Assy	4	210-10215
490A1000002-009	Guide Installation	1	490A1000000
490A1000002-001	Cable	12	490A1000002
490A1000001-001	Fixture	4	490A1000002
490A1000001-003	Stop	6	490A1000002
490A1000001-005	Washer	6	490A1000002
210-10227-1	Guide Tube	6	490A1000002
210-10235-1	Guide Foot	6	490A1000002
210-10236-1	Ball Unit Retainer	6	490A1000002
210-10237-1	Guide Housing	4	490A1000002
210-10237-2	Guide Housing	2	490A1000002
210-10238-1	Torque Tube	4	490A1000002
210-10238-2	Torque Tube	2	490A1000002
210-10239-1	Bearing Housing	6	490A1000002
210-10259-4	Bearing Retainer	6	490A1000002

TABLE 1– CLAH PARTS LIST (Continued)

STRUCTURE, GUIDE & TWISTLOCK INSTALLATIONS

PART NUMBER	DESCRIPTION	QTY PER CLAH	USING ASSY DWG REF
210-10217-1	Twistlock Instl	1	490A1000000
210-10217-2	Chain Drive	8	210-10217
210-10217-3	Cable	1	210-10217
210-10225-1	Clip, Lock Pin	1	210-10217
210-10226-1	Shims	12	210-10217
210-10241-1	Engagement Fitting	2	210-10217
210-10241-3	Engagement Fitting	2	210-10217
210-10241-5	Bearing, Sleeve	4	210-10241
210-10242-1	Twistlock	4	210-10217
210-10243-1	Retension Bolt	4	210-10217
210-10244-1	Sprocket/Cam	4	210-10217
210-10245-1	Eye End	8	210-10217
210-10245-2	Eye End	8	210-10217
210-10246-1	Washers	4	210-10217
210-10246-2	Washers	4	210-10217
210-10246-3	Washers	1	210-10217
210-10246-4	Washers	1	210-10217
210-10246-5	Washers	1	210-10217
210-10247-4	Idler	2	210-10217
210-10250-1	Link Assy	5	210-10217
210-10252-1	Mounting Assy	2	210-10217
210-10252-2	Mounting Assy	2	210-10217
210-10253-1	Shaft Idler	1	210-10217
210-10254-1	Mount Assy Actuator	1	210-10217
210-10255-1	Manual Lever	1	210-10217
210-10256-1	Lock Fitting	1	210-10217
210-10257-1	Cover, Chain Adapter	16	210-10217
210-10257-2	Cover, Chain	8	210-10217
210-10257-3	Cover, Chain	8	210-10217
210-10258-1	Plunger	4	210-10217
210-10259-1	Cover Plate	4	210-10217
210-10259-2	Cover Plate	4	210-10217
210-10259-3	Mounting Plate	12	210-10217
210-10261-1	Bellcrank & Sprocket Assy	2	210-10217
210-10261-2	Bellcrank & Sprocket Assy	1	210-10217
210-10261-3	Bellcrank & Sprocket Assy	1	210-10217
490A1000402-009	Markings Installation	1	490A1000000
490A1000400-001	Warning Marker	4	490A1000402
490A1000401-001	Caution Marker	1	490A1000402
490A1000403-001	Identification Plate	1	490A1000402

TABLE 1—CLAH PARTS LIST (Continued)

STRUCTURE, GUIDE & TWISTLOCK INSTALLATIONS

PART NUMBER	DESCRIPTION	QTY PER CLAH	USING ASSY DWG REF
NAS77-4-25	Bushing	4	210-10217
NAS77-12-47	Bushing	4	210-10217
NAS558-606-29	Key	4	210-10217
NAS1090-2	Hook	1	210-10217
NAS1335S3S1D	Lock Pin	1	210-10217
MS 21251B3S	Turnbucke Body	8	210-10217
MS 24585C-240	Spring	4	210-10217
MS 35756-8	Key	4	210-10217
MS 35756-35	Key	1	210-10217
HF-16-SS	Clamp	16	210-10217
27-1-B	Sleeve	2	210-10217
NAS77-6-18	Bushing	8	210-10215
MS 21209F4-10	Insert	16	210-10215
MS 21209F1-20	Insert	24	210-10220
MS 21209F4-15	Insert	16	210-10220
MS 21209F1-20	Insert	12	210-10221
MS 21241-12C24	Bearing Sleeve	8	210-10221
NAS77-10-42	Bushing	16	210-10223
NAS21209F4-15	Insert	6	210-10235
MS 21241-26C32	Bearing Sleeve	4	210-10241
MS 21242S-5K	Rod End Bearing	5	210-10250
MS 21242S-5KL	Rod End Bearing	5	210-10250
NAS513-5	Lock Washer	10	210-10250
NAS509-5	Nut	5	210-10250
NAS509L5	Nut	5	210-10250
MS 21251B8L	Turnbuckle	4	210-10251
AN665-80RA	Terminal	4	210-10251
MS 21252-8LL	Clevis End	4	210-10251
AN316-6	Nut	4	210-10251
MS 21209F8-20	Insert	1	210-10254
7721-0000-3	Ball Unit Assy	6	490A1000002
MS 21231-16	Bearing	6	490A1000002
NAS 1340S3S38D	Lock Pin	12	490A1000002
NAS1090-2	Hook	6	490A1000002
27-1-B	Sleeve	24	490A1000002

TABLE 2–CLAH PARTS LIST

ELECTRICAL

PART NUMBER	DESCRIPTION	QTY. PER CLAH	USING ASSY. DWG. REF.
490A2000100-009	Control Box Assy	1	490A2000300
490A2000101-009	Box Assy	1	490A2000100
490A2000101-017	Gasket	1	490A2000101
490A2000101-019	Cover Assy	1	490A2000100
490A2000101-021	Cable	2	490A2000101
490A2000101-029	Cable Assy	2	490A2000302
490A2000102-001	Ident Marker	1	490A2000100
490A2000200-009	Junction Box Assy	1	490A2000300
490A2000201-003	Chassis	1	490A2000200
490A2000201-005	Panel	1	490A2000200
490A2000201-007	Panel	1	490A2000200
490A2000201-009	Box Assy	1	490A2000200
490A2000201-011	Support	2	490A2000300
490A2000202-001	Ident Marker	1	490A2000200
490A2000202-003	Ident Marker	1	490A2000200
490A2000202-005	Ident Marker	1	490A2000200
490A2000202-007	Ident Marker	1	490A2000200
490A2000202-011	Ident Marker	1	490A2000200
490A2000300-001	Case	1	490A2000300
490A2000300-003	Support Shn.	2	490A2000300
490A2000300-004	Support Opp	2	490A2000300
490A2000300-009	Electrical Sys Instl	1	490A1000000
490A2000300-019	Storage Box Assy	1	490A2000300
490A2000301-003	Cover	5	490A2000300
490A2000301-005	Cover	3	490A2000300
490A2000301-007	Cover	1	490A2000300
490A2000301-009	Clip Assy	25	490A2000300
490A2000302-009	Cable Assy	1	490A2000300
490A2000302-019	Cable Assy	1	490A2000300
490A2000302-029	Cable Assy	1	490A2000300
490A2000302-039	Cable Assy	1	490A2000300
490A2000302-049	Cable Assy	1	490A2000300
490A2000302-059	Cable Assy	1	490A2000300
490A2000302-069	Cable Assy	1	490A2000300
490A2000302-079	Cable Assy	1	490A2000300
490A2000302-089	Cable Assy	1	490A2000300
490A2000302-099	Cable Assy	1	490A2000300
490A2000302-109	Cable Assy	4	490A2000300

TABLE 2–CLAH PARTS LIST (continued)

PART NUMBER	DESCRIPTION	QTY. PER CLAH	USING ASSY. DWG. REF.
451116-301	Socket Relay	1	490A2000100
MS27400-17	Relay	1	490A2000100
MS27785-23	Toggle Switch	1	490A2000100
MS27786-22	Toggle Switch	1	490A2000100
E1-2	Indicator	1	490A2000100
1M100-2	Switch	2	490A2000100
IP6	Bezel	6	490A2000100
1A16Y	Button	2	490A2000100
1A16W	Button	4	490A2000100
M39016/16-107L	Relay	1	490A2000100
RW74U2501F	Resistor	1	490A2000100
M81714/2-CA1	Module	12	490A1000100
M81714/2-CB1	Module	4	490A2000100
MRTB20E03-670	Diode Module	4	490A2000100
MS27186-2	Sealing Plug	6	490A2000100
M83723/28-20	Sealing Plug	116	490A2000100
M81714/5-1	Track	2	490A2000100
M39029/1-16-20	Pin Contact	38	490A2000100
NAS 557-16B	Grommet	2	490A2000100
SE21XE03	Terminal Stud	2	490A2000100
MS3474L14-19P	Elec. Connector (J202)	1	490A2000100
MS3474L22-55S	Elec. Connector (J201)	1	490A2000100
M7078/3-20-4	Wire	A/R	490A2000100
11390	Cable (55 Conductor)	A/R	490A2000100
11393	Cable (19 Conductor)	A/R	490A2000100
RT1301-1/8	Shrink Tube	A/R	490A2000100
MS3367-1-2	Red Tie Wrap	A/R	490A2000100
MS51844-1	Sleeve	2	490A2000101
SP-197-1	Hook	2	490A2000101
MS35333-76	Lock Washer	2	490A2000101
ZT104-160ACOT-CC	Cover	1	490A2000101
ZT104-160A-64-CC	Box	1	490A2000101
M6249	Adhesive	A/R	490A2000101
Black Ax	Permanent Ink	A/R	490A2000101
White 41	Permanent Ink	A/R	490A2000101
Fed. Spec. TT-L-32	Lacquer, Clear	A/R	490A2000101
Zero Mfg. Co. Case No. 256	Case	1	490A2000300

TABLE 2–CLAH PARTS LIST (continued)

PART NUMBER	DESCRIPTION	QTY. PER CLAH	USING ASSY. DWG. REF.
ZSP 2-204	Latches	2	490A2000300
ZSP1-122	Closure	2	490A2000300
MS3341-1-9	Bracket	11	490A2000300
MS3367-3-9	Tie Down Strap	25	490A2000300
OM422M12	Motor Assy	1	490A2000300
DC 731	Sealant	A/R	490A2000300
MS21919-DG5	Cable Clamp	7	490A2000300
MS21919-DG7	Cable Clamp	8	490A2000300
MS27039-1-14	Screw	2	490A2000300
MS27039-1-08	Screw	9	490A2000300
AN743-12	Bracket Support	4	490A2000300
AN743-13	Bracket Support	5	490A2000300
MS21042L3	Nut	11	490A2000300
AN960-10	Washer	11	490A2000300
MS3474L22-55P	Receptacle (J1)	1	490A2000200
MS3474L14-05S	Receptacle (J2)	1	490A2000200
MS3474L14-18S	Receptacle (J7)	1	490A2000200
MS3474L14-18SW	Receptacle (J8)	1	490A2000200
MS3474L14-18SX	Receptacle (J9)	1	490A2000200
MS3474L14-18SY	Receptacle (J10)	1	490A2000200
M81714/2-CA1	Module	22	490A2000200
M81714/2-CB1	Module	40	490A2000200
MRTB20E03-670	Diode Module	6	490A2000200
M39029/1-16-20	Pin Contact	60	490A2000200
M81714/5-1	Track	6	490A2000200
MRTBL-20	Track	2	490A2000200
M83723/28-20	Sealing Plug	485	490A2000200
M83723/28-16	Sealing Plug	10	490A2000200
MS27186-2	Sealing Plug	8	490A2000200
MS25274-2	Wire End Cap	16	490A2000200
M7078/3-20-4	Wire	A/R	490A2000200
11390	Cable (55 Conductor)	A/R	490A2000200
11393	Cable (19 Conductor)	A/R	490A2000200
RT1301-1/8	Shrink Tube	A/R	490A2000200
451116-301	Socket Relay	2	490A2000200
MS27400-17	Relay	2	490A2000200
MS27786-31	Switch	1	490A2000200
Series 41-101 Wht Fr.	Indicator Lamp	12	490A2000200
MS21059L3K	Nut Plate	25	490A2000301

TABLE 2–CLAH PARTS LIST (continued)

PART NUMBER	DESCRIPTION	QTY. PER CLAH	USING ASSY. DWG. REF.
MS3476L22-55P	Connector	1	490A2000302
MS3471L14-19P	Connector	1	490A2000302
MS3476L14-05P	Connector	1	490A2000302
MS3476L14-05S	Connector	1	490A2000302
MS3476L14-19S	Connector	3	490A2000302
MS3476L14-18S	Connector	4	490A2000302
MS3476L22-55S	Connector	1	490A2000302
MS3476L14-18PY	Connector	1	490A2000302
MS3476L14-18P	Connector	4	490A2000302
MS3476L14-18PW	Connector	1	490A2000302
MS3476L14-18PX	Connector	1	490A2000302
MS3456L14S-2P	Connector	1	490A2000302
MS3456L24-2P	Connector	1	490A2000302
MS3456L24-12P	Connector	1	490A2000302
MS3474L14-18P	Connector	1	490A2000302
M83723-69R2255N	Connector	1	490A2000302
M83723-83R2255N	Connector	1	490A2000302
W-C-596/20-2	Connector	1	490A2000302
MS3162-16-16	Pin	3	490A2000302
MS3162-8-8	Pin	3	490A2000302
MS3162-4-4	Pin	2	490A2000302
NAS1388-2	Splice	3	490A2000302
NAS1388-3	Splice	7	490A2000302
NAS1389-1	Splice	3	490A2000302
NAS1389-4	Splice	2	490A2000302
MS3158-22C	Backshell	3	490A2000302
MS3158-14C	Backshell	19	490A2000302
MS3158-24C	Backshell	2	490A2000302
622EN1-6	Microswitch	12	490A2000302
MS3348-4-6	Crimp Adapter	2	490A2000302
MS3109-03AC	Straight Boot	13	490A2000302
MS3109-06AC	Straight Boot	5	490A2000302
222D221-4	Rt Angle Boot	6	490A2000302
222D253-4	Rt Angle Boot	1	490A2000302
222D211-4	Rt Angle Boot	12	490A2000302
MS51844-1	Sleeve	1	490A2000302
462A011-3	2 Way "Y" Split	4	490A2000302
382A012-3	3 Way Split	2	490A2000302
RT350-3/8	Shrink Tube (Black)	A/R	490A2000302

TABLE 2–CLAH PARTS LIST (continued)

PART NUMBER	DESCRIPTION	QTY. PER CLAH	USING ASSY. DWG. REF.
RT350-1/2	Shrink Tube (Black)	A/R	490A2000302
RT350-1/2	Shrink Sleeve (Yellow)	A/R	490A2000302
RT350-3/4	Shrink Sleeve (Yellow)	A/R	490A2000302
AMP36161	Lug Terminal	2	490A2000302
M83723-70R22	Adapter	1	490A2000302
11390	Cable (55 Conductor)	A/R	490A2000302
11393	Cable (19 Conductor)	A/R	490A2000302
M707813-20-4	Cable	A/R	490A2000302
MS22759/16-10-9	Wire	A/R	490A2000302
MS22759/16-6-9	Wire	A/R	490A2000302
MS22759/16-8-9	Wire	A/R	490A2000302
MS22759/16-12-9	Wire	A/R	490A2000302
MS22759/16-16-9	Wire	A/R	490A2000302

TEST

PURPOSE

Tests were conducted to demonstrate the structural integrity, self-alignment capability, and latching and unlatching functions of the 490A1000000-009 container lift adapter handling device.

HARDWARE

The following equipment was used for the test program:

1. One commercial ANSI/ISO container, 8- x 8- x 20-foot, steel

2. One 35-ton mobile boom crane

3. One power unit 120V, 15 amp, 3 phase, 400 Hertz, -EQ86671

4. One beam and wire rope sling assembly

5. Deadweights - steel beams and lead blocks

REQUIREMENTS

1. Verification of dimensional accuracy and compatibility with the MILVAN or ANSI/ISO container.

2. Check of twistlock operation.

3. Demonstration that the CLAH was capable of engaging, locking onto, lifting and releasing a MILVAN or commercial ANSI/ISO 8- x 8- x 20-foot container with a design x 1.2 factor payload (33,300 x 1.2 or 39,960 lbs) and the required sling configuration.

4. Operation of the portable hand-operated control box and the electrical interface components.

5. Ground operation and checkout of the twistlock function with the portable control box.

PROCEDURE

Tests were performed using a commercial steel ANSI-ISO 8- x 8- x 20-foot container. The interface attaching slings were interconnected by a 12-inch-wide flange steel beam. The container gross test load of 39,960 lbs was accomplished by adding deadweight uniformly distributed inside the container (Figure 27). Prior to adding weight to the container, the

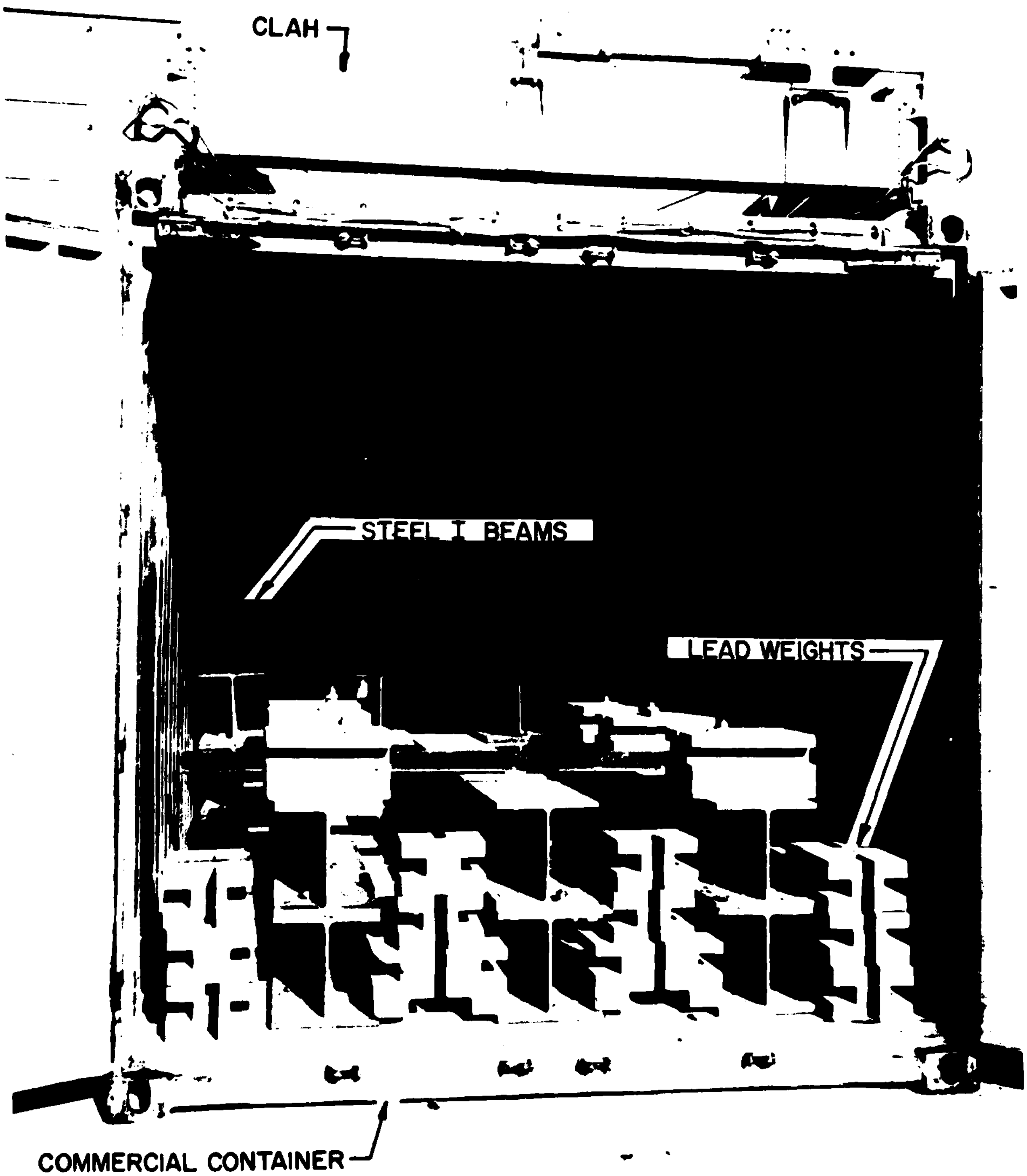


Figure 27. Weighted Container

container was weighed with a calibrated load cell and indicator to determine the tare weight required. Each lift adapter with the container was engaged and lifted and released a minimum of ten times. The load cell was balanced to eliminate rigging and CLAH deadweight. A 35-ton portable crane simulated the helicopter (Figure 28), utilizing 120V, 3 phase, 15 amps, 400 Hertz electrical power for the operational testing and a 28 VDC 1.2 amp power supply for the portable control panel operation. During the tests the adapters were verified for functional performance relative to the test requirements. Tests were accomplished by qualified test engineers, with customer witnesses. Test equipment was calibrated in accordance with Military Specification MIL-C-45662A, entitled, "Calibration System Requirements," and traceable to the National Bureau of Standards.

RESULTS

On 9 and 10 January, 1980, the two CLAHS were successfully functionally and structurally proof tested in the presence of the customer and designated witnesses at the Martin Marietta Aerospace, Baltimore Division Engineering Test Facility (Figures 28 and 29). Each CLAH was verified electrically and functionally using the hand-operated control panel. Each CLAH successfully engaged and lifted the ANSI/ISO test container the specified ten times. The actual gross test load lifted by each adapter was 39,970 lbs.

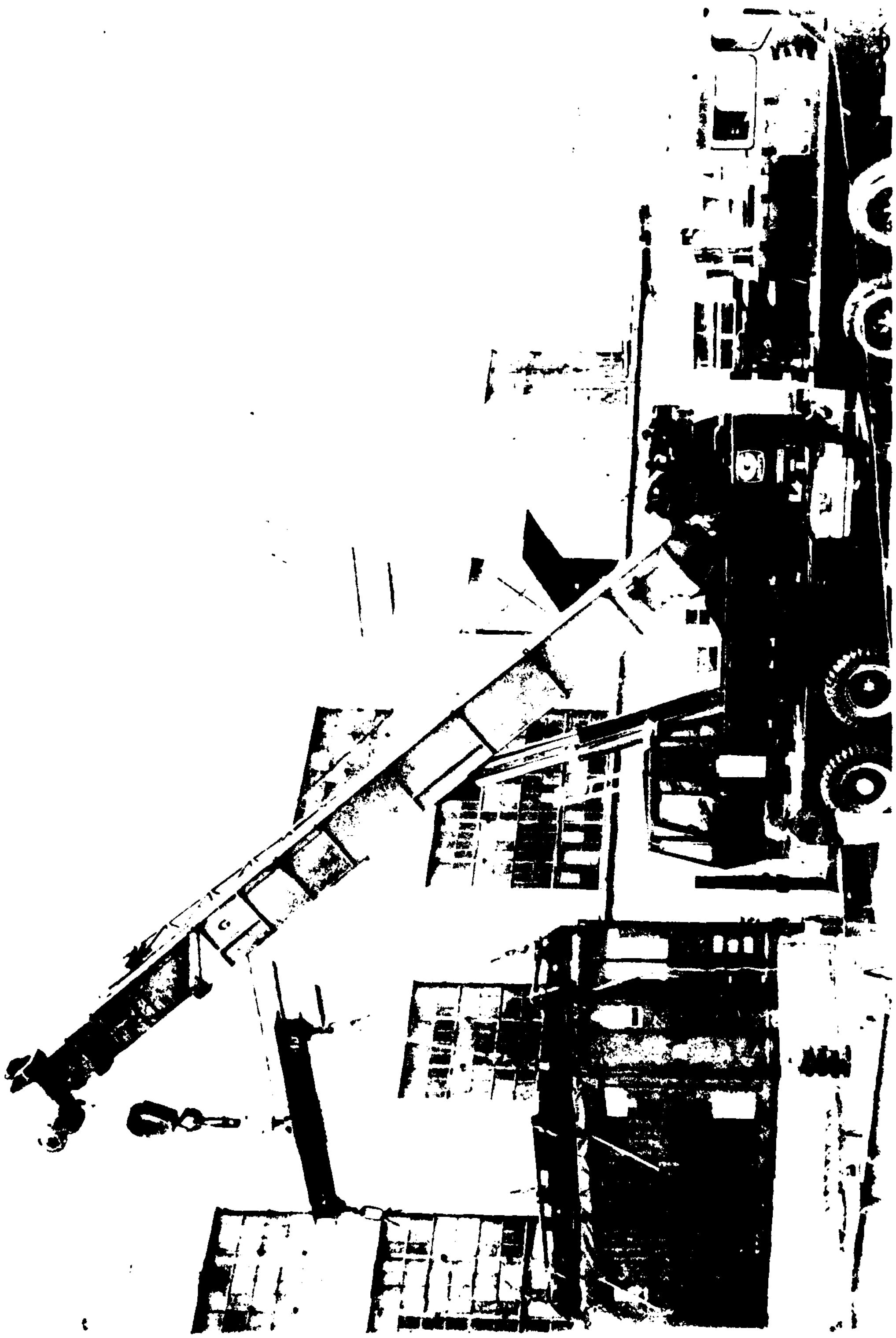


Figure 28. Testing With Crane

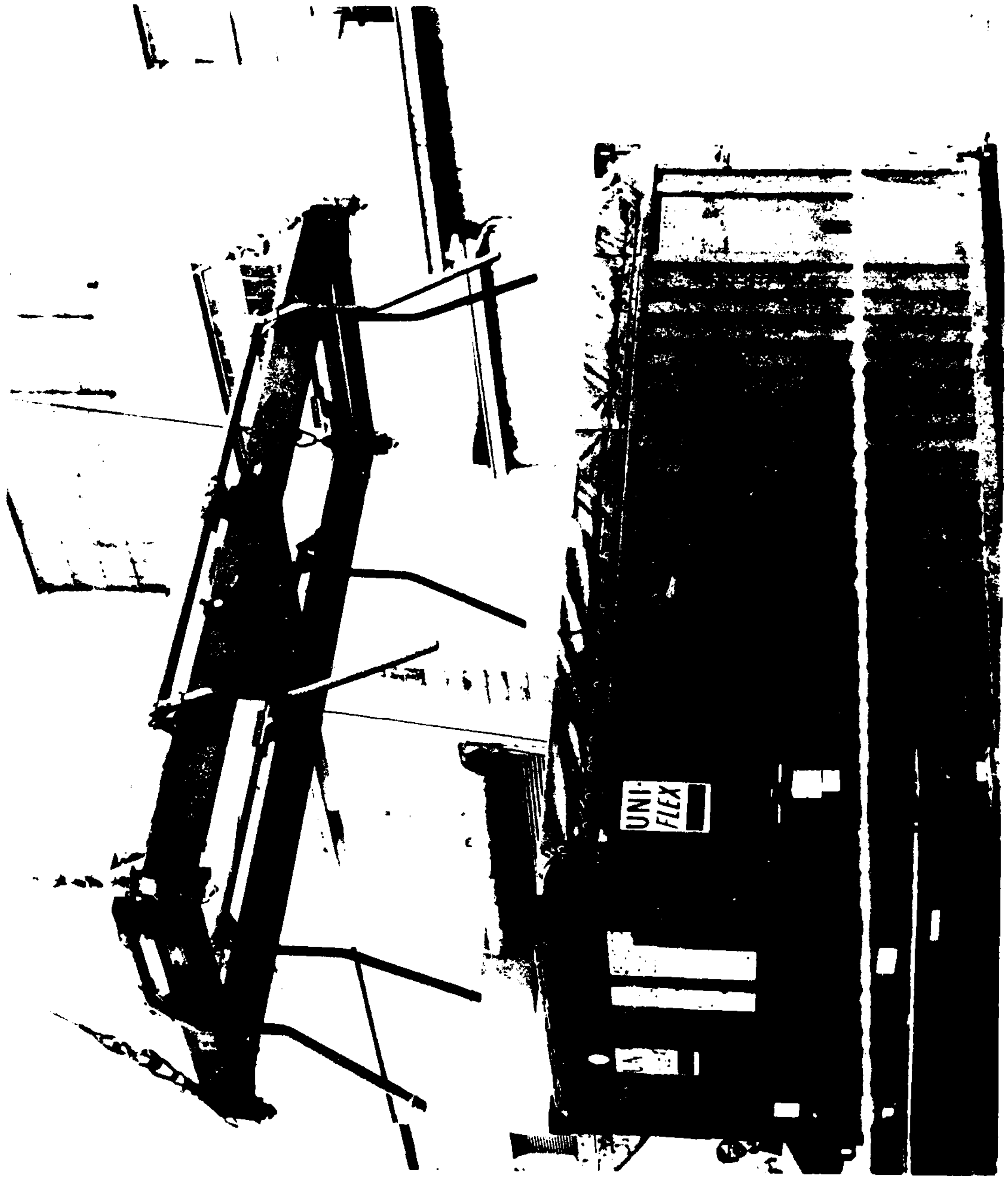


Figure 29. CLAH Test

Figure 29. Continued

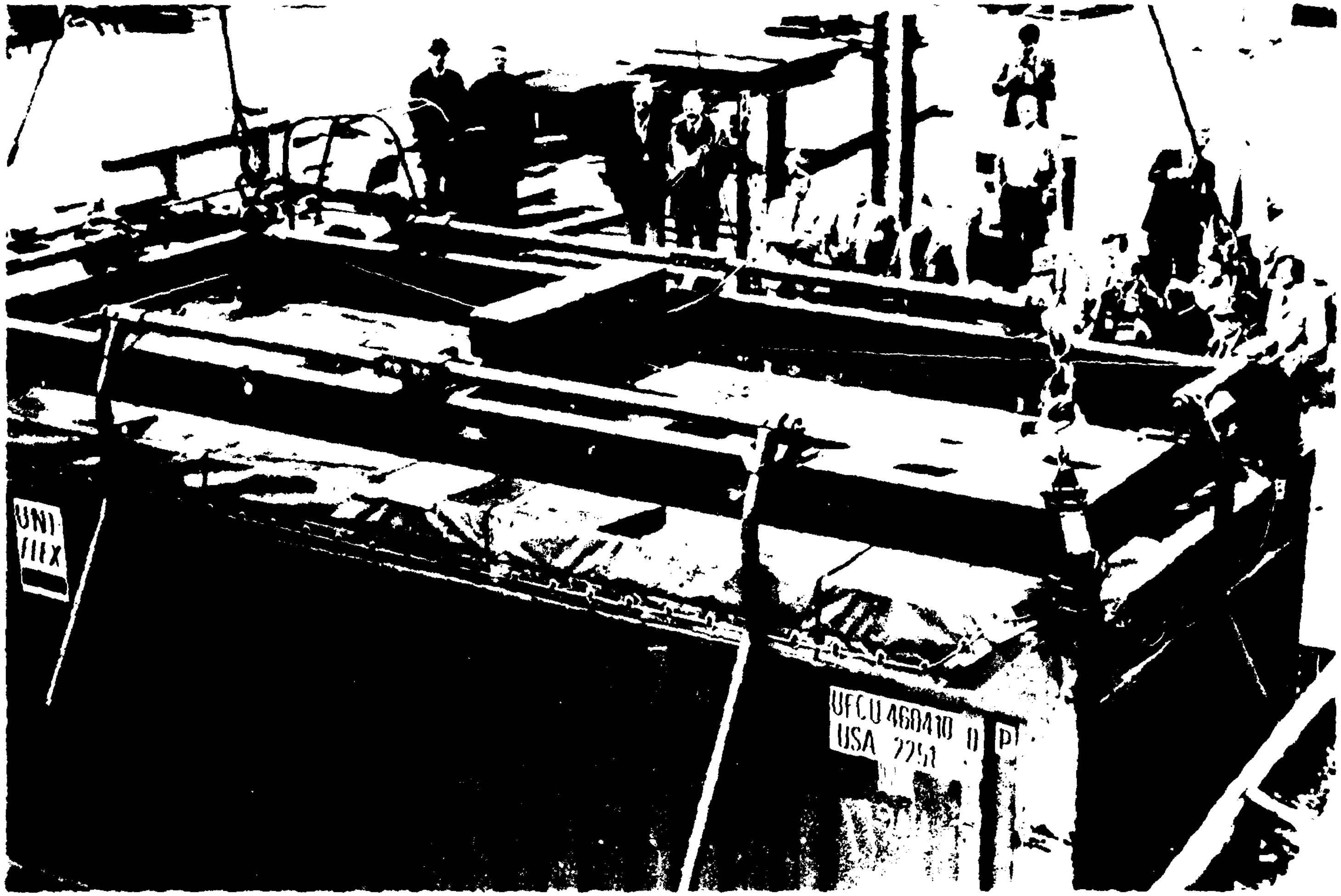


Figure 29. Continued

SOFTWARE

In order to operate, maintain, and support the deployed CLAH, reliability, maintainability, logistic, and cost analyses of the CLAH design were called for. An orientation/training session was conducted for Government personnel relative to operations, maintenance, and repair of the CLAH.

RELIABILITY

Reliability prediction for the CLAH was substantiated by a FAILURE MODES and EFFECTS ANALYSIS (FMEA) and vendor-provided component failure rates and FMEAs. The prediction of the reliability of the CLAH served as a foundation for ensuring the effectiveness of the CLAH in several ways:

1. Indicated areas where maintenance is required
2. Indicated skill and tools requirements
3. Indicated spares/logistics requirements
4. Indicated areas of potential reliability improvements in follow-on production units.

Results of the analysis indicate that the reliability of the CLAH is in the order of 0.99944. The gear case motor is the least reliable element in the system.

MAINTAINABILITY

Maintenance engineering analysis (MEA) was conducted to predict the maintenance manhours per CLAH operating hour (MH/OH), mean-time-to-repair (MTTR), and elapsed and total manhours for the CLAH as a unit. Scheduled inspection, lubrication, and service requirements were established. The purpose of the maintenance engineering analysis and maintainability prediction was basically twofold:

1. To reveal areas of poor maintainability which may justify product improvement, modification, or change of design in future follow-on production units.
2. To develop data that will aid the user in determining whether the predicted availability, the quality, quantity of personnel, tools and test equipment are adequate and consistent with the needs of the system operational requirements.

Toward these ends, this analysis developed the maintenance manhours per operating hour and the mean time to repair. All anticipated scheduled inspections, lubrication, and servicing requirements and frequencies were established. The need for any special tools was assessed.

The analysis indicates that the motor is the largest contributer to the corrective maintenance manhours; 44 percent of the total.

The daily "walk around" inspection is the largest contributer to the total active maintenance. It is recommended that after several thousand hours of successful field experience have been accumulated that the daily inspection requirements be reviewed for possible simplification.

LOGISTICS

Predicted spare parts requirements as a function of CLAH operating hours categorized to the individual subsystem assemblies and part levels were established. The following predicted spare parts list was originated based on the reliability analysis. This list is based on 100,000 operating hours.

SPARES PER 100,000 OPERATING HOURS

SOURCE	NOMENCLATURE	PART NUMBER	USING ASSY FOR REF	QUANTITY
	GUIDE SYSTEM			
Martin Marietta	Guide Tube	210-10227-1	490A1000002-009	15
	ELECTRICAL SYSTEM			
Martin Marietta	Cable	490A2000302-009	490A2000300-009	1
Martin Marietta	Cable	490A2000302-039	490A2000300-009	1
Martin Marietta	Cable	490A2000302-089	490A2000300-009	1
Plessey Industries	Gear Case Motor	0M422M12	490A2000300-009	13
Microswitch Division	Micro Switch	622EN1-6	490A2000300-109	1
Martin Marietta	Shim	210-10226-1	490A2000300-009	2
Microswitch Division	Indicator	1E1-2	490A2000100-009	1
Microswitch Division	Switch	1M100-2	490A2000100-009	1
Matrix Science Division	Diode	MRTB20E02-670	490A2000100-009	1
			490A2000200-009	1
	Switch	MS27786-22	490A2000100-009	1
	Switch	MS27786-23	490A2000100-009	1
	Switch	MS27786-31	490A2000200-009	1
General Electric	Lamp	327	490A2000100-009	2
Grayhill Inc.	Indicator Lamp	Series 41-10WHT	490A2000200-009	1
		FR	490A2000200-009	1
	TWISTLOCK SYSTEM			
Martin Marietta	Sleeve Bearing	210-10241-5	210-10241-3	2
	Sleeve Bearing	MS21241-16C22	210-10256-2	2
	Sleeve Bearing	MS21241-32C24	210-10252-1	2
	Sleeve Bearing	MS21241-12C24	210-10221-1	2
Martin Marietta	Link Tube Ass'y	210-10250-2	210-10250-1	1
Martin Marietta	Sprocket	210-10248-1	210-10261-1	1
	Chain	ANSISTD No 35 (3/8 pitch) .39 pitches long including connecting link at each end.	210-10217-1	6
Martin Marietta	Twistlock Fitting	210-10242-1	210-10217-1	6
Martin Marietta	Sprocket/Cam	210-10244-1	210-10217-1	1

COST

To facilitate planning for production of CLAHs, a rough order of magnitude production procurement cost prediction was prepared based on 300 units over a five-year period with 100 units the first year and 50 units per year for the remaining four years. Cost predictions were based on the production prototype 490A1000000-009 with the recommended changes for production (refer to Recommendations). Cost data was subcategorized to include nonrecurring material, labor and liaison engineering. Cost data was presented to the customer under separate cover.

ORIENTATION AND TRAINING

An Instruction Manual was prepared addressing all operating and servicing instructions for the CLAH.

A General Maintenance/Training Manual was prepared defining CLAH operation, maintenance, and repair.

A two-day orientation/training session was conducted at the Martin Marietta, Baltimore Division facility for the Government personnel to familiarize them with the actual hardware along with instructions relative to CLAH operation, maintenance and repair. Training included classroom instructions and on-site CLAH inspection and operations.

Classroom instructions provided general introduction to CLAH, configuration description, operation, preflight checkout, sling/helicopter hookup, umbilical hookup, maintenance, lubrication, fault isolation and troubleshooting, repair, adjustments and calibrations.

A disassembly and teardown inspection of various CLAH subassemblies and parts was conducted; i.e., the actuator, twistlock microswitches, guide tube, chain, etc., to establish and identify isolation and maintenance or repair procedures. Parts were reassembled and the CLAH's operation condition was verified by performance of the checkout instructions found in the Instruction Manual.

Following the orientation/training period, the Instruction Manual and the General Maintenance/Training Manual were updated to reflect the technical and operational inputs and recommendations generated by the experienced helicopter crew members who had participated in the training activity.

PRODUCIBILITY STUDY

A cursory producibility study was conducted by engineering taking into consideration experiences associated with manufacture and assembly of the preproduction units. Study included use of forgings/castings in lieu of hogged-out fittings, fastener substitution as a saving for rate production, and possible structure/mechanical/electrical changes to enhance

producibility. Results from this study disclosed that the present honeycomb box structure framework with associated structural fittings and fasteners appears optimum from a design/weight/cost standpoint. However, with the exception of the corner twistlock fitting and the inside corner sprocket housing fitting, considerable machining cost saving can be realized using aluminum die forgings for almost all the fittings attaching to the box structure. Due to the multiple faying surface attachment provisions of the corner fitting, and the machining required to accommodate the plunger, twistlock and microswitches, a die-forging replacement for this fitting is impractical. A casting would require going to steel, increasing weight, and the resulting saving in machining would be negligible. Similar reasoning applies to the inside corner sprocket housing fitting. It is recommended that the current design for these two fittings be evaluated prior to production.

CONCLUSIONS

The two preproduction CLAHs have been successfully manufactured in accordance with the current specifications and drawings (Figure 26).

Except for minor changes for production, such as forgings in lieu of hogged-out fittings, etc., the current engineering drawings, prepared in accordance with MIL-D-1000, Form 2 requirements, are suitable for CLAH production.

It has been successfully demonstrated that the two preproduction CLAHs are capable of engaging, locking onto, lifting and releasing a MILVAN or commercial ANSI/ISO 8- x 8- x 20-foot container.

Structure design was verified by test, proving that the structure is capable of lifting the design payload.

The CLAH is now ready for customer field test and evaluation.

RECOMMENDATIONS

The current CLAH configuration has evolved from and has benefited from a series of technical research and study programs as well as testing of experimental container lifting devices. Our recommendations, therefore, are based on what further changes can be made in hardware or concept to arrive at an optimum configuration for production with weight and cost as the primary considerations.

The following cost saving changes are recommended for production:

(a) Utilize die-forgings in lieu of hogged-out fittings. Approximately 19 fittings with multiple usage fall in this category.

(b) Reduce the size of the junction box. Form a cost standpoint, the stowage box and the junction box should be replaced by one box (8 inches high x 10½ inches wide x 30 inches long serving both functions.

The following changes are recommended to improve reliability:

(a) Reliability analysis indicates that the reliability of the CLAH is in the order of 0.99944. In view of the fact that the analysis indicates the gear case motor to be the least reliable element in the system, it is recommended that it be thoroughly developed to minimize the expense of supplying this costly spare.

(b) It is recommended that in future procurement all MS347 series electrical connectors be changed to weatherproof M83723 series.

Recommend a producibility study prior to a CLAH production contract establishing an optimum configuration incorporating changes originating/resulting from flight evaluation and operational suitability testing.